Bulletin 31. April, 1895.

KINGSTON, RHODE ISLAND.

SOME SPECIAL ORCHARD TREATMENT OF THE APPLE, PEAR AND QUINCE.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

PRESS OF E. L. FREEMAN & SON, PRINTERS TO THE STATE.

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FIG. I.
A plate of Roxbury Russet apples from a tree sprayed May 30, with the Bordeaux mixture and Paris green.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 31.

TREATMENT OF PEAR ORCHARD.

L. F. KINNEY.

In Bulletin No. 27 of this Station an account is given of the results that followed the treatment with the Bordeaux mixture of three pear trees at West Kingston, in an orchard owned by Mrs. J. G. Clarke. This year (1894) the other trees in this orchard have been treated, the main object being to compare the cost of the materials and labor required to do the work with the money value of the additional product of saleable pears due to the treatment. Twenty-two trees were included in this experiment, six of which received no special treatment. All of the other trees were sprayed five times during the season with the Bordeaux mixture. The mixture used for the first treatment, which was made early in May before the blossoms opened, was prepared by the twenty-two gallon formula, or six pounds of sulphate of copper, four pounds of caustic lime, and twenty-two gallons of water. For the other treatments, which were made on May 29th, June 25th, July 17th, and August 9th, forty gallons of water were used to dilute the mixture instead of twenty-two. Paris green was added to the mixture used on May 29th and June 25th, at the rate of one ounce to ten gallons of the mixture.

A "Peerless" brass spray pump with a "Bordeaux" nozzle, manufactured by the Deming Co., Salem, Ohio, was mainly used in this work. For the five treatments of the sixteen trees two hundred and forty gallons of Bordeaux mixture were used. The sulphate of copper, lime and Paris green required for the preparation of this cost one dollar and eighty-five cents, and its preparation and application required the labor of one man two hours, which cost twenty-five cents, and the labor of two men and a team three hours, which cost about one dollar more, making the cost for labor one dollar and twenty-five cents, or the total cost for material and labor three dollars and ten cents, or at the rate of nearly nineteen and four-tenths of a cent for each tree.

Six of the trees treated were Clapp's Favorite. The fruit of this variety grew quickly and seemed to resist in a large measure the attack of the common parasites without artificial protection. No record was made when these pears were picked, and it is doubtful if the benefit derived from the treatment would more than balance the cost of material and labor, although Mrs. Clarke, who had the pears gathered in our absence, thinks the fruit from the sprayed trees was decidedly larger and fairer than that picked from the two trees of this kind which were left untreated for comparison.

SPRAYED. NOT SPRAYED.

FIG. II.

Pears from two Sheldon trees standing side by side in Mrs. Clark's orchard.

Eight of the other trees sprayed were Sheldons, the fruit of which had suffered severe injury in previous years from the attack of the Entomosporium and other fungi. The treatment of these trees was unquestionably a profitable operation — the average pro-

duct of the eight trees being about one bushel of pears each, of which twenty-six quarts were saleable and worth in the local market at the time gathered about eighty cents; while the average product from the unsprayed trees of this kind was six quarts each, of which only two quarts were saleable and worth less than seven cents. Thus the average gain in the value of the product from each sprayed tree was about seventy-three cents. By subtracting from this the average cost of the treatment, which was nineteen and four-tenths of a cent per tree, we have as the profit derived from the treatment fifty-three cents and six mills for each tree, or four dollars twenty-eight cents and eight mills as the total profit from spraying the eight Sheldon trees.

One of the other sprayed trees was an Anjou. With this variety spraying the tree made the difference between a fair crop of saleable pears, about one-half bushel, and none at all. The leaves from the unsprayed tree fell nearly three weeks earlier than those from the treated tree, leaving the pears hanging to the bare limbs until they, like the leaves, dropped prematurely, being at the time too immature to ripen and be saleable; while those on the tree that was sprayed with the Bordeaux mixture grew to the normal size, and when gathered ripened well. The profit derived from the treatment of this tree was estimated to be about twenty-five cents.

The remaining sprayed tree was a Lawrence. With this variety the effect of the treatment was decidedly beneficial, and what has been said concerning the Anjou will apply equally well to this kind, with the exception, perhaps, that the Lawrence did not drop its leaves quite as early.

In this orchard the parasitic fungi, particularly the Entomosporium and Fusicladium, had become so well established that they regularly prevented the Sheldon, Anjou and Lawrence trees from maturing their fruit, and by their growth upon the foliage (and fruit) unquestionably damaged the quality of the Clapp's Favorite pears.

This treatment has shown (1) that when the trees were artificially protected from the attack of these fungi they could mature their fruit; (2) that a fair profit resulted from the operation.

Had the soil in this orchard been regularly fertilized and the trees pruned the value of the crop would have been considerably

increased, while the cost of the treatment would have been no more.

Fig. II shows the yield from two adjacent Sheldon trees, one treated and the other not. The cost of the treatment was about nineteen and one-half cents. The value of the fruit from the treated tree was about eighty cents while the fruit from the un-treated tree was worth less than seven cents in the market at the time it was gathered.

FIG. III.
Section of treated Anjou tree in Mrs. Clark's orchard.

Figs. III and IV are from photographs of parts of the Anjou trees. The negatives were made September 27th. The part of the tree shown in Fig. III was treated and the part of the one shown in Fig. IV was not.

FIG. IV.
Section of Anjou tree not treated.

The Entomosporium and Fusicladium were both abundant in this orchard during the past season. The injuries of the former were the more conspicuous early in the summer but were somewhat obscured later by the luxuriant growth of the Fusicladium. The Leaf Spot was also present upon many of the trees and probably did considerable damage. Where the green parts of the trees were kept covered

with the Bordeaux mixture in the early part of the season they were mainly protected from the injuries of all these fungi. When possible the under surface of the leaves (and fruit) should be sprayed as well as the upper.

The fruit in this orchard was not severely attacked by worms, although the addition of the Paris green to the Bordeaux mixture which is to be used for the second and third applications should not probably be omitted.

The results of the work in Mrs. Clarke's orchard on the whole correspond with those obtained the preceding year and furnish additional proof that pear trees exposed to injury by the common parasitic fungi may be mainly protected by artificial means, and that a fair profit may reasonably be expected to result from such protection.

TREATMENT OF QUINCE BUSHES.

The Entomosporium that causes the leaf blight and cracking of the pear also attacks the foliage of the quince, but until last season when Mr. D. B. Rodman, of Glen Rock, very generously offered the use of his orchard for experimental purposes, there has been no opportunity for treating this fruit at this Station. The bushes in Mr. Rodman's orchard were too close together and their branches too much interlaced to admit of any separation into rows or blocks with definite boundaries. It was therefore arranged to spray the bushes at both ends of the enclosure and leave the central portion untreated for comparison.

The material used was prepared in the same manner as that applied to the pear trees in Mrs. Clarke's orchard. The first application was made May 29th, the second June 26th, the third July 17th and the last August 9th. During the season I visited the orchard several times to note the progress of the Entomosporium. The foliage was well covered with the Bordeaux mixture but it did not entirely check the growth of the parasite. This I attribute largely to two defects in the treatment. (1) The bushes were so thick that a man could not well work among them, so the mixture was sprayed over their tops and fell mainly upon the upper side of the leaves. This left the under surface of the leaves exposed to the

attack of the Entomosporium. (2) There should have been an application of the Bordeaux mixture either just before or after the buds started into growth in the spring to destroy as many as possible of the germs that had survived the winter.

The quince rust was conspicuous upon many of the bushes and it did not appear to be affected by the treatment.

FIG. V.

Quinces from the treated section of Mr. Rodman's orchard.

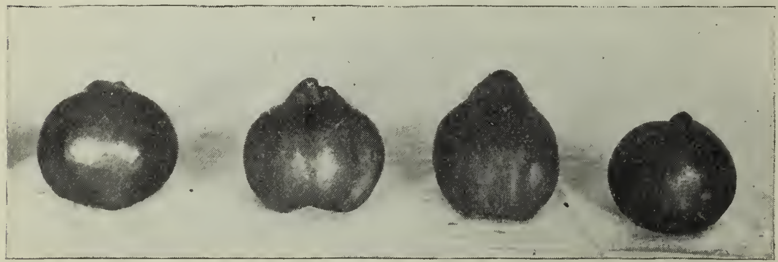

FIG. VI.

Quinces from the section of Mr. Rodman's orchard that was not treated.

The rot (Sphæropsis) also attacked a large proportion of the fruit just as it began to mature. This appeared to be equally abundant upon the fruit of bushes that were sprayed and upon the fruit of those that were not.

At the close of the season the fruit upon the bushes that had been sprayed seemed to be larger, and altogether was probably somewhat better than that upon the trees in the central part of the field; yet it was evident that with the treatment given only partial protection from the attack of the Entomosporium and other fungi

had been secured. The fruit was gathered by Mr. Rodman. Figs. V and VI are from photographs of quinces from a sprayed and unsprayed bush.

TREATMENT OF APPLE TREES ATTACKED BY CANKER WORMS. (*Anisopteryx vernata.*)

From reports received at the Experiment Station it seems that these worms appeared upon fruit and other trees last spring in many localities in the State where their presence had not been observed before, at least for many years. They appeared in one orchard near this Station, and for the purpose of illustration arrangements were made with the owner, Mr. Samuel Adams, to treat the trees to destroy the worms. We were not notified of their presence until late in May. The foliage of the trees was somewhat brown and the worms, many of them were one-half inch or more in length. They had done considerable damage and at this time were too large to be very satisfactorily treated with any insecticide. However, the treatment of several of the trees was undertaken.

On May 30th three large apple trees were sprayed with Paris green and the Bordeaux mixture (1 oz. to 6 gallons.) The Paris green was applied with the Bordeaux mixture for the double purpose of preventing it from injuring the foliage and at the same time by the single application destroying any injurious fungi that might be present upon the trees. During the same day two other trees were sprayed with kerosene emulsion. One of these was a small tree and every part of it was thoroughly wet. The leaves of this tree were examined upon the two following days and it was found that nearly all of the smaller worms had been killed by the treatment but many of the larger ones soon recovered and appeared to be in as good condition as before the tree was sprayed. The worms gradually disappeared from the trees that were sprayed with the Paris green, and the foliage was but slightly injured by the treatment. Had the application been made earlier in the season, a smaller proportion of Paris green would probably have been equally effectual in destroying the worms,

and if less had been used there would have been no danger of injuring the leaves if the proper precautions were observed to prevent it from settling.

The worms were not present upon the untreated trees in sufficiently large numbers to cause their defoliation and consequently did not severely damage the crop. It is quite probable, however, that these worms will increase in the localities where they have appeared, and all persons having fruit trees should be prepared to protect them from their attack. Spraying the trees early in the spring when the worms first appear as already described is probably the most effectual method, but if preferred a band covered with printers ink or tar, or a trough containing water or some other liquid may be placed around the trunk of each. The function of the band or trough is to catch the mature females, which have no wings, as they attempt to crawl up the trunks in the spring. If this obstruction that is placed in their way performs its function perfectly then no canker worms will appear upon the trees, but too frequently due to some defect in the operation, the females will find a way either under or over the obstructions and later the worms appear as if no protection had been attempted. The canker worms having mainly disappeared from Mr. Adams' orchard soon after the treatment, May 30th, they received no further attention but for the further protection of two of the trees, viz., a Roxbury Russet and a R. I. Greening, from the attack of fungous parasites, they were sprayed again July 17th with the Bordeaux mixture. All of the work in connection with the treatment was thoroughly performed and the results were very gratifying. The health and vigor of the trees were noticeably promoted by the treatment, and when the apples were gathered October 1st Mr. Adams remarked that "he had never raised such Roxbury Russets before." There was just a barrel-full of the large Roxbury Russets that were free from worm-holes and other blemishes, and less than one-half bushel of second quality fruit.

The apples from another Roxbury Russet tree that stood near by were very inferior to those from the treated tree. The total yield from the two trees was about the same but there was nearly a barrel-full of second quality apples and less than one-half bushel that were of fair size and free from blemishes on the untreated tree.

Total number of apples from tree No. 1		551
" " free from blemishes	471	
" " more or less injured by worms	80	
Total number of apples from tree No. 2		505
" " free from blemishes	70	
" " more or less injured by worms	435	

The superior quality of the Greening apples from the treated tree was quite as remarkable as in the case of the Roxbury Russets. A second tree near by was picked at the same time for the purpose of comparing the fruit.

Total number of apples from treated Greening tree		767
" " free from blemishes	645	
" " more or less injured by worms	122	
Total number of apples from untreated Greening tree		744
" " free from blemishes	218	
" " more or less injured by worms	526	

The principal object of the treatment of these trees was to destroy the canker worms that had appeared upon them. This was mainly accomplished by the application of the combined insecticide and fungicide on May 30th. The canker worms, however, soon disappeared from the other trees so that comparatively little advantage was thus secured, but the treatment was effectual in checking the depredations of the larvæ of the codling moth and other orchard pests, and was thus on the whole a very profitable operation. It should be mentioned here that many of the Greening apples were slightly russeted on the exposed side. This was evidently due in part, at least, to the treatment, but it did not apparently injure the apples in the least unless perhaps their appearance was slightly damaged.

TREATMENT OF APPLE TREES AT NORTH SCITUATE.

In order to show more particularly the commercial advantage that can be derived from the use of fungicides and insecticides upon apple trees it was arranged with Hon. Martin S. Smith, of North Scituate, to co-operate with him in the treatment of one of

his orchards containing nearly 150 bearing trees, and also with Mr. Geo. W. Burlingame, who was then a member of the senior class in the College here, to look after the details of this work. The orchard was not in a high state of cultivation, although the land appeared to be naturally well adapted to the growth of this fruit. There were growing in the orchard about an equal number of trees of each of the following varieties, viz: King, Chenango, Stump, Northern Spy, R. I. Greening and Baldwin. The treatment given consisted in spraying the main part of the trees three times during the season. The first application was made on April 2d, before the trees had leaved out. The Bordeaux mixture, prepared by the twenty-two gallon formula,* was used alone for this application. The second and third applications were made on May 21st and June 23d respectively. For use at these dates the Bordeaux mixture was prepared by the forty-gallon formula, that is, 6 lbs. sulphate of copper, 4 lbs. caustic lime, and 40 gallons of water; to this was added Paris green at the rate of 1 lb. to each 200 gallons of the mixture. There was but little rain during the summer. This condition was favorable inasmuch as the materials that were sprayed over the foliage in the spring adhered well during the season, but the drouth became excessive during July and August, and it soon was evident that the principal object of the treatment in this orchard was, in a large degree at least, defeated. The leaves of many of the trees turned yellow, and much of the fruit fell to the ground before it was half grown. For this reason the crop of fruit was unusually small, and the original plan that provided for a careful gathering, assorting and marketing of all the apples from the orchard was mainly abandoned, but an estimate was made of the relative proportion of the good and poor fruit of the various kinds from the sprayed and the unsprayed trees as follows: Two trees of a kind as near alike as could be found, one having been sprayed and the other not, were selected, and from one side of each of these, beginning at the lower limbs and picking the apples clean to the uppermost, one bushel of fruit was picked. The apples were then examined, and those that were more or less injured by worms or the Fusicladium (scab) were counted, and the

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* See page 89 under treatment of pear orchard.

per cent., by number, of the fruit that was sound was figured and noted. The results were as follows :

	Tree Sprayed.			Tree Not Sprayed.		
	No. of apples in bush.	Per cent. sound.	No. wormy.	No. of apples in bush.	Per cent. sound.	No. wormy.
King	143	64.34	51	200	46 0	108
Chenango	250	72.8	68	248	68.5	78
Stump	210	71.9	59	240	48 3	124
Northern Spy	180	66.11	61	211	28 9	150
R. I. Greening	168	82 14	30	214	38.7	131
Baldwin	229	82.53	40	271	39 5	164
Total	1180	439.82	309	1384	269.9	755
Average	196.6	73.3	51 5	230.7	45.0	125.83

The cost of the treatment is estimated by Mr. Burlingame as follows:

466 gallons of Bordeaux mixture	$9 68
1½ lbs. of Paris green	0 45
Labor of three men, preparing and applying the mixture, 60 hours	9 00
Use of team 20 hours	3 00
Total	$22 13

This amount when divided among the 131 trees treated makes the cost of the treatment 16.9 cents per tree. There can be but little doubt but that the value of the fruit was increased by the treatment considerably more than this, although for reasons already stated no attempt was made to estimate the value of the crop from the entire orchard. In a letter from Mr. Smith he writes as follows concerning the results of the treatment: "The early varieties of apples hung upon the trees longer than usual, grew larger and were much less affected by the rot. Among the late varieties the R. I. Greening and Roxbury Russets were especially noticeable for size, smoothness and freedom from the usual depredations of insects. The scab which has heretofore been more prevalent upon the Pippin than any other variety of apple was found upon but few specimens this year. The percentage of wormy fruit was

much smaller among all varieties." In reviewing the work in this orchard the following features should be noted, viz:

1st. The fruit from the sprayed trees averaged 14.8 per cent. larger than that from the trees that were not treated, or according to the figures given on the preceding page, there were 34.1 less apples in a bushel from the sprayed trees than from the others.

2nd. 28.3 per cent. more of the apples upon the sprayed trees were sound than upon those that were not.

3rd. Among the apples examined there was upon an average 75.1 more wormy specimens per bushel in the fruit gathered from the untreated trees than from the others.

4th. It was noticed by both Mr. Smith and Mr. Burlingame that the apples from the sprayed trees did not decay so soon as those from the untreated trees.

5th. The codling moth was the principal offender in this orchard, although the increased size of the fruit on the sprayed trees was probably partially due to the protection of the foliage by the use of the Bordeaux mixture, from the attack of fungous diseases.

FIG. VII.

6th. The treatment should have insured a more complete protection of the apples from the attack of the codling moth than it did. This may have been due to the third application having been made too late, there having been five weeks between it and the second.

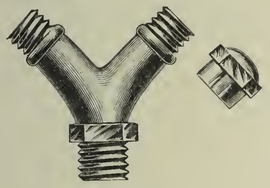

FIG. VIII.

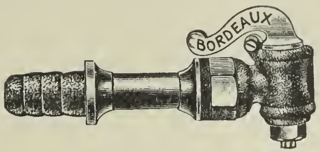

FIG. IX.

A "Deming-Improved" spray pump, with a "Deming-vemorel" and a "Bordeaux" spray nozzle, was used in this orchard. Two lines of one-half inch hose were used on the pump. The "Deming-vemorel" nozzle was attached to the end of one of these and used for spraying the lower limbs, while the "Bordeaux" nozzle was attached to the end of the other line of hose and was used for spraying the higher branches that could not be readily reached with the finer spray of the "Deming-vemorel." The mixture was agitated by operating a wooden paddle in the barrel. When thus equipped this apparatus makes a highly satisfactory spraying outfit—certainly one of the best that there is at present upon the market. At Fig. VII a Deming pump is shown with a short piece of hose and a Deming-vemorel nozzle. Fig. VIII shows a double connection for attaching two lines of hose, with a tight cap for closing one opening when desired, and Fig. IX a Bordeaux nozzle. But whatever methods or apparatus are used in treating the tops of trees the care of their roots should not be forgotten, for all of our orchard fruits are the products of high cultivation. Trees stand year after year in the same spot, and in order to insure profitable crops of choice fruit, the soil beneath the trees should be intelligently cultivated and regularly fertilized.

Bulletin 32. June, 1895.

KINGSTON, RHODE ISLAND.

ANALYSES

OF

COMMERCIAL FERTILIZERS.

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RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 32.

ANALYSES OF COMMERCIAL FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL AND C. L SARGENT.

In the following pages will be found analyses of a portion of the official samples of commercial fertilizers which have been collected in connection with the regular inspection for the year 1895.

The selling price has been omitted this season, for the reason that the cost of cartage to certain localities in the State is great, and fertilizers collected at such points show, of necessity, a greater difference between the selling price and valuation than others collected at points where the cost of transportation is small. By adopting this policy injustice may be avoided and also the temptation for one manufacturer to make use of such exceptional prices and publish them to the detriment of his competitors.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
480	Baker's Complete Manure	H. J. Baker & Bro., 93, 95 and 97 William St., New York	E. O. Easterbrook, Warren.
523	Bowker's Potato Phosphate	Bowker Fert. Co., 43 Chatham St., Boston.	E. D. Forrow, Centreville.
524	Bowker's Potato and Vegetable Manure	" " " " "	Hoxie Bros. Co., Phenix.
457	Bowker's Stockbridge Manure for Potatoes and Vegetables	" " " " "	Seth Anthony, Portsmouth.
430	Bradley's Complete Manure for Potatoes and Vegetables	Bradley Fert. Co., State St., Boston, Mass.	L. H. Peabody, Middletown.
447	Bradley's Potato Manure	" " " " "	P. J. Grey & Son, Adamsville.
495	Brightman's High Grade Potato and Root Manure.	W. J. Brightman & Co., Tiverton	F. P. Babcock, Westerly.
437	C. C. F. Co.'s Odorless Chem. Compound Fert. for Potatoes	Chemical Compound Fert. Co., Dighton, Mass	Geo. A. Weaver Co., Newport.
501	Clark's Cove Fert. Co.'s Bay State Potato Manure	Clark's Cove Fert. Co., State St., Boston.	J. W. Smith, Mapleville.
491	Coe's Special Potato Manure	E. Frank Coe Co., 16 Burling Slip, New York	Sullivan & Perry, Shannock.
443	Crocker's Potato, Hop and Tobacco Phosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	E. F. Ash, Tiverton 4 Corners.
438	Crocker's Special Potato Manure	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Geo. A. Weaver Co., Newport.

Sample No.	Name of Brand.	Water.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
			Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available.					
													Found.	Guaranteed.	Found.	Guaranteed.		
480	Baker's Complete Potato Manure.	11.26	.45	1.19	1.74	**3.38**	*3.30*	4.61	1.96	.43	**7.00**	....	**6.57**	*5.75*	**10.83**	*10.*	3.50	*$30.02*
523	Bowker's Potato Phosphate......	12.00	.54	....	1.30	**1.84**	*1.50*	4.45	3.85	4.85	**13.15**	*10.*	**8.30**	*8.*	**2.17**	*2.*	*	*19.38*
524	Bowker's Potato and Vegetable Manure.....................	11.79	1.00	....	1.79	**2.79**	*2.50*	7.33	2.43	2.66	**12.42**	*10.*	**9.76**	*8.*	**4.46**	*4.*	*	*25.45*
457	Bowker's Stockbridge Manure for Potatoes and Vegetables.......	10.70	1.35	.81	1.66	**3.82**	*3.25*	6 17	2.13	2.25	**10.55**	*8*	**8.30**	*6.*	**8.24**	*7.*	*	*30 59*
430	Bradley's Complete Manure for Potatoes and Vegetables.......	11 50	1.64	..	2.06	**3.70**	*3.70*	3.94	5.50	1.82	**11.26**	*9.*	**9.44**	*8.*	**6.00**	*6*	*	*28.63*
447	Bradley's Potato Manure......	14.36	.14	....	2.44	**2.58**	*2.50*	5.08	99	2 53	**8.60**	*8.*	**6.07**	*6.*	**5.37**	*5.*	*	*21.50*
495	Brightman's High-Grade Potato and Root Manure.............	10.80	1.40	..	2 24	**3.64**	*3 30*	5.07	2.94	1.79	**9.80**	*9.*	**8.01**	*8.*	**7.13**	*7.*	*	*28.05*
437	C. C. F. Co.'s Odorless Chemical Compound Fert. for Potatoes..	2.04	3.00	..	....	**3.00**	*3.00*	...	93	12.55	**13.48**	....	**.93**	....	**1.76**	*1.*	*	*16 62*
501	Clark's Cove Fert. Co.'s Bay State Potato Manure...............	11.66	.40	....	2.12	**2.52**	*2 47*	4.62	2.28	1.85	**8.75**	*7.*	**6.90**	*6.*	**5.84**	*5.*	*	*22.25*
491	Coe's Special Potato Manure.....	10.70	....	....	1.86	**1.86**	*1.65*	8.03	2.83	1.57	**12.43**	*11.*	**10.86**	*9.*	**3.25**	*3.*	.10	*22.92*
443	Crocker's Potato, Hop and Tobacco Phosphate................	13.49	....	...	2.18	**2.18**	*2.00*	7.46	2.19	1 75	**11.40**	*10.*	**9.65**	*10.*	**3.56**	*3.25*	*	*22 45*
438	Crocker's Special Potato Manure.	11.50	....	....	3.88	**3.88**	*3.70*	6.88	1.59	1.56	**10.03**	*9.*	**8.47**	*8.*	**5.71**	*5.4*	*	*28.56*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found on page 28.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
520	Cumberland Potato Fertilizer	Cumberland Bone—Phosphate Co., Portland, Me.	W. King & Son, Kenyon.
462	Darling's Potato and Root Crop Manure	L. B. Darling Fert. Co., Pawtucket, R. I.	H. C. Anthony, Portsmouth.
482	Great Eastern Vegetable, Vine and Tobacco Fert.	Great Eastern Fert. Co., Rutland, Vt.	J. Q. A. Gardiner, Barrington.
488	Mapes' Manure for Potatoes	Mapes Formula and Peruvian Guano Co., New York	Martin Bros., Barrington.
428	National Fert. Co.'s Chittenden Root Fertilizer	National Fert. Co., Bridgeport, Conn.	Geo. Coggeshall, Middletown.
451	Pacific Guano Co.'s Special Potato Manure	Pacific Guano Co., Box 1368, Boston	D. D. Gifford, Portsmouth.
420	Parmenter & Polsey's Special Potato Fertilizer	Parmenter & Polsey, Peabody, Mass.	Wm. G. Rose, Slocumville.
475	Quinnipiac Potato Manure	The Quinnipiac Co., 92 State St., Boston	Seymour Bros., Warren.
514	Read's Vegetable and Vine Fertilizer	Read Fertilizer Co., New York	John F. James, Moosup Valley.
478	Standard Potato and Tobacco Fertilizer	Standard Fert. Co., State St., Boston	Seymour Bros., Warren.
421	Wilcox's Potato, Onion and Tobacco Manure	Leander Wilcox, Mystic, Conn.	E. E. Kenyon, Usquepaug.
425	Williams & Clark's High Grade Special for Potatoes, etc.	Williams & Clark Fert. Co., 92 State St., Boston	Albert L Chace, Middletown.
427	Williams & Clark's Potato Phosphate	Williams & Clark Fert. Co., 92 State St., Boston	" " " "

Sample No.	Name of Brand.	Water.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
			Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
520	Cumberland Potato Fertilizer....	11 69	....	....	2.24	**2.24**	*2.06*	6.13	3.68	2.25	**12.06**	*11.*	**9.81**	*9.*	**3.05**	*3.*	*	*$22.45*
462	Darling's Potato and Root Crop Manure....................	8.55	.51	...	3.57	**4.08**	*3.00*	1.92	4.68	5.50	**12.10**	*10.*	**6.60**	*6*	**6.65**	*7.*	4.80	*28.98*
482	Great Eastern Vegetable, Vine and Tobacco Fertilizer...........	12.12	....	....	2.35	**2.35**	*2.06*	6.23	1.52	1.28	**9.03**	*9.*	**7.75**	*8.*	**6.79**	*6.*	*	*22.83*
488	Mapes' Manure for Potatoes.....	7.29	1.74	.53	1.66	**3.93**	*3.70*	5.67	2.33	2.39	**10.39**	*8.*	**8.00**	*8.*	**7.69**	*6.*	.80	*30.89*
428	National Fert. Co.'s Chittenden Root Fertilizer.......	11.49	....	1.23	2.27	**3.50**	*3.30*	3.59	5.29	1.94	**10.82**	*10.*	**8.88**	*8.*	**5.90**	*6.*	*	*28 26*
451	Pacific Guano Co.'s Special Potato Manure.................	10.10	1.60	....	1 54	**3.14**	*2.47*	5.08	1.33	1.19	**7.60**	*7.*	**6.41**	*5.*	**5.61**	*5.*	1 00	*23.61*
420	Parmenter & Polsey's Special Potato Fertilizer	12.36	.65	.21	2.51	**3.37**	*3.29*	4.76	4.28	1.30	**10.34**	*9.*	**9.04**	*8.*	**8.11**	*7.*	2.44	*29.97*
475	Quinnipiac Potato Manure......	8.69	1.52	...	1.46	**2.98**	*2.47*	4.43	2.73	1.23	**8.39**	*7.*	**7.16**	*6.*	**5.31**	*5.*	.88	*23.59*
514	Read's Vegetable and Vine Fertilizer.................. ...	10.68	....	....	1.84	**1.84**	*1.65*	5.23	1.52	1.27	**8.02**	*7.*	**6.75**	*6*	**8.77**	*8.*	*	*22.41*
478	Standard Potato and Tobacco Fertilizer......................	14.02	.32	....	1.85	**2.17**	*2.05*	5.37	3.18	2.38	**10.92**	*9.*	**8.55**	*8.*	**3.31**	*3.*	*	*20.94*
421	Wilcox's Potato, Onion and Tobacco Manure................	15.90	.81	.21	2.64	**3.66**	*3.30*	4.99	2 39	1.19	**8.57**	*8.*	**7.38**	*7.*	**6.02**	*6*	1 60	*27.72*
425	Williams & Clark's High-Grade Special for Potatoes, etc.......	10.94	1.49	....	1.90	**3.39**	*3.70*	5.59	3.84	2.24	**11.67**	*8.*	**9.43**	*7.*	**7.17**	*7.*	*	*29.02*
427	Williams & Clark's Potato Phosphate..................... ..	14.24	.20	...	2.58	**2.78**	*2.47*	3.72	2.02	2.56	**8.30**	*7.*	**5.74**	*6.*	**5.71**	*5*	*	*21.95*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.
[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.
[2] The schedule of prices used in estimating these values is to be found on page 28.

Sample No.	Name of Brand.	Wholesale Dealer.	Place of Collection.	Purchaser.
453	Unleached Hard-Wood Ashes.........	Allison, Stroup & Co., New York, N. Y..	Portsmouth.	I. L. Fish, Portsmouth.....
463	" " "	" " " " " ..	"	Henry Hedly, Portsmouth...
417	" " "	T. H. Frauley, Brookline, Mass..........	W. Kingston	J. G. Johnson, So. Ferry....
454	" " "	" " " "	Portsmouth.	....
490	" " "	" " " "	Middletown.	Leonard Brown, So. Portsmouth..................
497	" " "	" " " "	Wickford Jc.	....
498	" " "	" " " "	" "	L. D. Rathbun, Exeter Hill.
416	Canada Unleached Wood Ashes.......	Monroe, Lalor & Co., Oswego, N. Y......	Jackson.....	I. W. Brayton, Fiskeville....
499	" " " "	" " " " "	Wickford Jc.	G. H. Brown, Lafayette.....

Sample No.	Name of Brand.	Date of Collection.	Water.	Phosphoric acid found.	Phosphoric acid guaranteed.	Potash found.	Potash guaranteed.	Valuation of phosphoric acid and potash contained in one ton.*
453	Hard-Wood Unleached Ashes.	April 11, 1895.	14.86	.64	......	3.59	......	$4 41
463	" " "	April 11, 1895.	13.88	1.30	......	5.89	......	7 48
417	" " "	March 1, 1895.	11.33	2.51	1.50	6.66	5.00	9 50
454	" " "	April 11, 1895.	6.92	2.42	......	7 51	5.00	10 31
490	" " "	April 16, 1895.	8.13	2.92	......	6.66	......	9 91
497	" " "[1]	April 18, 1895.	7.50	2.89	1.50	7.24	5.00	10 49
498	" " "[2]	April 18, 1895.	9.74	2.03	1.50	6 42	5.00	8 77
416	Canada Unleached Wood Ashes.	Oct. 21, 1894.	8.78	1.16	1.00	6.08	4.50	7 54
499	" " " "	April 18, 1895.	13.52	1.30	1.00	4.39	4.00	5 91

*The price allowed for phosphoric acid and potash in wood ashes is 5 cents for the former and 5¼ cents per pound for the latter, or the same as for potash in the form of "high grade sulphate." The ashes contained considerable lime and some magnesia, the amount of which was not determined and for which no *commercial* value has been allowed. The value of each to the farmer, or *agricultural* value, is dependent upon the amount of the same in the soil and the wants of the crop to be raised.

[1] Light colored ashes.

[2] Dark colored ashes.

The commercial value of fertilizers for this season is nothing more nor less than a statement of the average price at which the same amounts of potash, phosphoric acid and nitrogen in the best form of chemicals and fertilizer stock, could have been bought at retail in our larger markets during the six months preceding March 1, 1895.

The following schedule of prices for use in estimating the commercial value of fertilizers is that adopted by the Connecticut, Massachusetts, New Jersey and Rhode Island Agricultural Experiment Stations for the year 1895, and represents the average prices in our larger markets for the six months preceding March 1. In the case of wholesale quotations about 20 per cent. has been added to raise them to a retail basis.

AVERAGE RETAIL COST OF POTASH, PHOSPHORIC ACID AND NITROGEN IN THE FORM OF CHEMICALS AND FERTILIZER STOCK, FOR THE SIX MONTHS PRECEDING MARCH 1, 1895.

	Cents per Pound.
Nitrogen in Ammonia Salts	18½
" " Nitrates	15
Organic Nitrogen in dry and fine ground fish, meat, blood, and in high grade mixed fertilizers	16½
Organic Nitrogen in cotton seed meal	12
" " " fine bone and tankage	16
" " " fine medium bone and tankage	14
" " " medium bone and tankage	11
" " " coarse bone and tankage	5
" " " hair, horn-shavings and coarse fish scraps	5
Phosphoric acid soluble in water	6
" " " " ammonia citrate	5½
Insoluble phosphoric acid in mixed fertilizers	2
Phosphoric acid in fine bone and tankage	5½
" " " fine medium bone and tankage	4½
" " " medium bone and tankage	3
" " " coarse bone and tankage	2
" " " fine ground fish, cotton-seed meal and wood ashes	5
Potash as high grade sulphate, ashes, etc., and in mixtures free from muriates or chlorides	5¼
Potash as muriate or in forms containing muriates or chlorides	4½
Organic nitrogen in feed stuffs	15
Phosphoric acids in feed stuffs	5
Potash in feed stuffs	5¼

For an explanation of the method of calculating the commercial value, see BULLETIN 16, page 34.

The difference between the commercial valuation and the cost of the fertilizer goes to cover grinding and mixing, interest on investment, freight, rebagging, agents' commissions, bad bills, etc., and finally profits. It remains for the individual farmer to decide whether he will pay the difference or buy his chemicals and mix his own fertilizers. The cost of mixing as estimated by Rhode Island farmers who have tried it, varies from $1.00 to $1.50 per ton.

For information in relation to the headings used in the preceding tables of analyses, and for a discussion of the special value of the various forms of nitrogen, phosphoric acid potash, see BULLETIN 16, pages 35–37.

It is a significant fact that many fertilizers are claimed to contain *sulphate of potash* or actual potash *equal to a given amount of sulphate of potash.* This is evidently done for one or both of the following reasons: (1) It is well known that tobacco, hops, sugar beats and potatoes are of better quality if grown with sulphate of potash than with the muriate, *or in other words that a large quantity of chlorine lowers the quality of these crops.* (2) Ten per cent. of sulphate of potash is really equal to about five per cent. of *actual potash*, and hence by stating it as sulphate the uninformed farmer is led to believe that twice the actual amount of potash is present. The only way by which the farmer may be sure of obtaining fertilizers containing little chlorine is by watching the analyses or by buying the chemicals and mixing his own goods.

Bulletin 33. October, 1895.

KINGSTON, RHODE ISLAND.

FERTILIZERS.

POTATOES.

POTATO SCAB.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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*Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 33.

ANALYSES OF COMMERCIAL FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL AND C. L. SARGENT.

542. Muriate of Potash. Sold by L. B. Darling Fert. Co., Pawtucket, R. I.
510. Muriate of Potash. Sold by Halliday Bros., East Providence, agents for National Fert. Co., Bridgeport, Conn.
546. Canada Unleached Wood Ashes. Purchased by I. W. Brayton, Fiskeville, of Munroe, Lalor & Co., Oswego, N. Y.

	542.	*510.* Per Cent.	*546.*
Water	.19	1.27	8.03
Potash	51.84	50.15	4.30
Phosphoric Acid	....	...	1.23
Valuation per Ton*	$16.66	$45.14	†$5.75

544. Nitrate of Soda. Sold by Mason, Chapin & Co., Providence, R. I.
543. Nitrate of Soda. Sold by L. B. Darling Fert. Co., Pawtucket, R. I.
460. Fine Ground Dry Fish. Sold by Seth Anthony, Portsmouth, Agent for Bowker Fert. Co., Boston, Mass.

	544.	*543.* Per Cent.	*460.*
Water	1.22	.85	7.29
Nitrogen	15.14	15.47	8.19
Phosphoric Acid	....	....	6.50
Valuation per Ton*	$45.42	$46.41	$33.53

* The schedule of Prices used in estimating these values is to be found in BULLETIN 32, page 28.
† Valuation of the phosphoric acid and potash contained in one ton.

GROUND BONES AND TANKAGE.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
458	Bowker's Fine Ground Bone	Bowker Fert. Co., Boston, Mass	Seth Anthony, Portsmouth.
459	" Tankage	" " " "	" " "
509	Bradley's Fine Ground Bone	Bradley Fert. Co., Boston, Mass	Halliday Bros., E Providence.
432	Clark's Cove White Oak Pure Ground Bone	Clark's Cove Fert. Co., Boston, Mass.	Chas. H. Ward, Middletown.
536	Cooper's Bone Dust	P. Cooper's Glue Factory, New York, N.Y.	W. A. Potter & Co., Providence.
526	Cumberland Fine Ground Bone	Cumberland Bone-phosphate Co., Portland, Me.	Hoxie Bros. Co., Phenix.
465	Darling's Fine Ground Bone	L. B. Darling Fert. Co., Pawtucket, R. I.	W. E. Barrett & Co., Providence.
418	Parmenter & Polsey's Pure Ground Bone	Parmenter & Polsey, Peabody, Mass	Wm. G. Rose, Slocumville.
468	Shoemaker's Swift Sure Bone Meal	M. L. Shoemaker & Co., Philadelphia, Pa.	Wardwell Lumber Co., Bristol.

GROUND BONES AND TANKAGE.

Sample No.	Name of Brand.	Water.	Total nitrogen found.	Total nitrogen guaranteed.	Total phosphoric acid found.	Total phosphoric acid guaranteed.	Mechanical Analysis. Finer than one-fiftieth inch—(fine).	Finer than one-twenty-fifth inch—(fine medium).	Finer than one-twelfth inch—(medium).	Coarser than one-twelfth inch—(coarse).	Valuation of the nitrogen and phosphoric acid in one ton.
458	Bowker's Fine Ground Bone*....................	6.62	3.11	2.47	20.21	18.00	......	......	......	......	$28.62
459	" Tankage	9.78	6.47	6.59	10.21	8.00	42.33	19.78	21.85	16.04	25.06
509	Bradley's Fine Ground Bone.....................	9.13	2.33	2.50	22.72	21.00	59.00	30.68	10.32	......	29.35
432	Clark's Cove White Oak Pure Ground Bone	11.63	2 55	2.47	21.77	20.00	44.38	35 97	19.65	......	27.53
536	Cooper's Bone Dust............................	2.66	1.79	......	28.08	......	55 21	20.52	15.12	9.15	30.77
526	Cumberland Fine Ground Bone..................	10.85	2.92	2.50	20.95	21.00	41.12	40.47	18.41	......	27.75
465	Darling's Fine Ground Bone......................	5.83	2.50	2.50	22.80	20.00	69.58	21.09	9.33	......	30.61
418	Parmenter & Polsey's Pure Ground Bone..........	8.80	2.94	2.88	25.41	16.00	12.24	54.04	31.20	2 52	28.48
468	Shoemaker's Swift Sure Bone Meal................	4.40	5.17	4.12	23.16	20.60	61 84	27.68	10.48	......	38.41

* This material had evidently been slightly acidulated, for it contained 1.37 per cent. of soluble and 10.84 of reverted phosphoric acid; its valuation is calculated upon the same basis as in mixed fertilizers except that the insoluble phosphoric acid is valued at 3 cents per pound.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
479	Baker's A. A. Ammoniated Superphosphate.....	H. J. Baker & Bro., 93, 95 and 97 William St., New York........................	E. O. Easterbrook, Warren.
484	" Complete Grass Manure.................	H. J. Baker & Bro., 93, 95 and 97 William St., New York..................	" " "
471	Bowker's Farm and Garden Phosphate.	Bowker Fert. Co., 43 Chatham St., Boston.	Wardwell Lumber Co., Bristol.
531	" Fish and Potash, "D"................	" " " " "	T. B. Segar, Hope Valley.
522	" Hill and Drill Phosphate..............	" " " " "	E. D. Forrow, Centreville.
538	" Lawn and Garden Dressing	" " " " "	Walter A. Potter & Co , Providence.
545	" Square Brand Bone and Potash.......	" " " " "	Peter Lennon, Pawtucket.
455	" Stockbridge Manure for Corn.........	" " " " "	Seth Anthony, Portsmouth.
456	" " " " Onions.......	" " " " "	" " "
466	" " " " Strawberries. .	" " " " "	Wardwell Lumber Co., Bristol.
467	" " " " Top Dressing.	" " " " "	" " " "
521	" Sure Crop Phosphate..........	" " " " "	E. D. Forrow, Centreville.

Sample No.	Name of Brand.	Water.	Nitrogen. Nitrogen in nitrates.	Nitrogen. Nitrogen in ammonia salts.[1]	Nitrogen. Nitrogen in organic matter.	Nitrogen. Total nitrogen found.	Nitrogen. Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total found.	Phosphoric Acid. Total guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
479	Baker's A. A. Ammoniated Superphosphate	17.33	.48	1.15	1.15	**2.78**	*2.47*	8.33	2.14	69	**11.16**	....	**10.47**	*10.*	**3.36**	*2.*	*	*$25.13*
484	Baker's Complete Grass Manure.	12.18	1.21	1 30	1.31	**3.82**	*3.71*	3.72	2.77	.56	**7.05**	....	**6.49**	*5.*	**7.98**	*7.*	*	*27.68*
471	Bowker's Farm and Garden Phosphate	13.39	.48	....	1 34	**1.82**	*1.50*	6.10	3.05	3.90	**13.05**	*10.*	**9.15**	*8.*	**2.28**	*2.*	*	*20.15*
531	Bowker's Fish and Potash, "D"	10.34	.26	....	2.82	**3.08**	*2.25*	1.88	2.28	5.46	**9.62**	*8.*	**4.16**	....	**2.71**	*2.*	*	*19.47*
522	Bowker's Hill and Drill Phosphate	12 25	.69	..	1.89	**2.58**	*2.50*	7.48	1.95	3.16	**12.59**	*12.*	**9.43**	*9.*	**2.29**	*2.*	*	*22.75*
538	Bowker's Lawn and Garden Dressing	5.99	2.07	1.95	....	**4.02**	*3 25*	4.86	1.25	6 27	**12.38**	*8.*	**6.11**	*6.*	**5.70**	*5.*	*	*28.28*
545	Bowker's Square Brand Bone and Potash	8.88	....	....	1 83	**1.83**	*1 50*	.69	5.69	7.42	**13.80**	...	**6.38**	*5.5*	**2.66**	*2.*	*	*18.49*
455	Bowker's Stockbridge Manure for Corn	12.56	1.84	..	1.71	**3.55**	*3.25*	8.01	1.99	1.92	**11.92**	*10.*	**10.00**	*8.*	**4.66**	*4.*	*	*27.93*
456	Bowker's Stockbridge Manure for Onions	9.13	3.49	....	1.77	**5.26**	*4 50*	2.81	2.37	3.81	**8.99**	8.	**5.18**	*7.*	**6.75**	*5.*	*	*29.89*
466	Bowker's Stockbridge Manure for Strawberries	8.09	.87	....	1.91	**2.78**	*2.50*	7 33	3.13	3 38	**13.84**	*7.*	**10.46**	*6.*	**4.41**	*4.*	.50	*27.03*
467	Bowker's Stockbridge Manure for Top Dressing	9.96	3.42	....	1.75	**5.17**	*5.00*	4.77	2.72	1 91	**9.40**	*6.*	**7.49**	*4.*	**7.07**	*6.*	*	*31.88*
521	Bowker's Sure Crop Phosphate	12.43	.33	..	.74	**1.07**	*.75*	3.33	6.32	3.85	**13.50**	*10.*	**9.65**	*8.*	**1.20**	*1.*	*	*17.00*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
477	Bradley's Ammoniated Bone Phosphate	Bradley Fert. Co., State St., Boston	Seymour Bros., Warren.
516	" Complete Manure for Corn and Grain	" " " " "	Byron H. Nixon, Summit.
448	" Fish and Potash, "B"	" " " " "	P. J. Gray & Son, Adamsville.
431	" X. L. Superphosphate of Lime	" " " " "	L. H. Peabody, Middletown.
446	Brightman's Fish and Potash	W. J. Brightman & Co., Tiverton, R. I.	P. J. Gray & Son, Adamsville.
450	" Superphosphate	" " " " "	C. C. Mitchel, Portsmouth.
449	Church's Fish and Potash, "D"	Daniel T. Church, Tiverton, R. I.	Humphrey & Church, Tiverton.
528	" Special Fertilizer, "B"	" " " "	W. E. Browning, Hope Valley.
429	" Standard Fertilizer, "C"	" " " "	A. A. Anthony, Middletown.
511	Chem. Comp. Fert. Co.'s Homestead C. C. F. for Lawns and Grass	Chemical Compound Fert. Co., Dighton, Mass.	Halliday Bros., E. Providence.
435	Chem. Comp. Fert. Co.'s Odorless C. C. F. for Corn	Chemical Compound Fert. Co., Dighton, Mass	Geo. A. Weaver Co., Newport.
503	Clark's Cove Fert. Co.'s Bay State Fertilizer	Clark's Cove Fert. Co., State St., Boston.	J. W. Smith, Mapleville.
504	" " " " " G. G.	" " " " "	" " "

Sample No.	Name of Brand.	Water.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
477	Bradley's Ammoniated Bone Phosphate	13 63	2.22	..	.24	**2.46**	*1.65*	6.65	2.18	2.11	**10.94**	*10.*	**8.83**	*8.*	**1.98**	*1.*	*	*$20.46*
516	Bradley's Complete Manure for Corn and Grain	9.78	1.62	..	1 82	**3.44**	*3.30*	4.45	5.02	4.32	**13.79**	*13.*	**9.47**	*12.*	**6.15**	*3.*	*	*28.99*
448	Bradley's Fish and Potash, "B"	16.77	....	....	2.48	**2.48**	*2.07*	3.07	3.64	2.07	**8.78**	*7.5*	**6.71**	*6.*	**2.39**	*2*	*	*18.85*
431	Bradley's X. L. Superphosphate of Lime	13.38	.48	....	2.36	**2.84**	*2.50*	6.67	3 11	1.87	**11.65**	*11.*	**9.78**	*9.*	**2.56**	*2.*	*	*23.71*
446	Brightman's Fish and Potash	17 19	....	....	1.98	**1.98**	*2.07*	2.96	3.66	2.07	**8.69**	*7.5*	**6.62**	*6.*	**2.50**	*2.*	*	*17 19*
450	Brightman's Superphosphate	13.18	.60	....	2 13	**2.73**	*2.50*	3.40	2.70	2.42	**8.52**	*8.*	**6.10**	*6.*	**5.52**	*5.*	*	*21.82*
449	Church's Fish and Potash, "D"	16.71	....	....	1.93	**1.93**	*2.07*	3.06	4.02	1.79	**8.87**	*7 5*	**7.08**	*6.*	**2.52**	*2.*	*	*17.45*
528	Church's Special Fertilizer, "B"	10.18	1.66	..	1.80	**3.46**	*3.72*	1 91	5.76	2.79	**10.46**	*9.*	**7.67**	*8.*	**5.33**	*6.*	*	*25.47*
429	Church's Standard Fertilizer, "C"	15 20	.37	....	2.47	**2.84**	*2.50*	3.49	2.53	2 62	**8.64**	*8.*	**6.02**	*6*	**5.53**	*5.*	*	*22.26*
511	Chemical Comp. Fert. Co.'s Homestead C.C.F. for Lawn and Grass	9.10	4.77	....	....	**4.77**	*5.40*	.26	5 48	.61	**6.35**	...	**5.74**	....	**1.02**	*1.*	*	*21.81*
435	Chemical Comp. Fert. Co.'s Odorless C. C F. for Corn	2.77	3.35	....	....	**3.35**	*3.00*	. ..	.97	12 46	**13.43**	....	**.97**	....	**1.75**	*1.5*	*	*17.68*
503	Clark's Cove Fert. Co.'s Bay State Fertilizer	13.22	.46	....	2.03	**2.49**	*2 47*	6.09	4.92	1.80	**12.87**	*10.*	**11.07**	*9.*	**2.24**	*2.*	*	*23.60*
504	Clark's Cove Fert. Co.'s Bay State Fertilizer, G. G	13.19	....	..	2.52	**2.52**	*1.85*	7 20	1.88	1.33	**10.41**	*10.*	**9.08**	*8.5*	**2.71**	*2*	*	*22.00*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
433	Clark's Cove Fert. Co.'s Great Planet "A" Manure	Clark's Cove Fert. Co., State St., Boston.	Chas. H. Ward, Middletown.
530	" " " King Philip Alkaline Guano	" " " "	W. F. Joslin, Hope Valley.
502	Clark's Cove Fert. Co.'s Potato and Tobacco Fertilizer	" " " "	J. W. Smith, Mapleville.
517	Coe's Alkaline Bone	E. Frank Coe Co., 16 Burling Slip, New York	J. A. Woodmansee, W. Kingston.
492	" High Grade Ammoniated Bone Superphosphate	E. Frank Coe Co., 16 Burling Slip, New York	Sullivan & Perry, Shannock.
424	Coe's Red Brand Excelsior Guano	E. Frank Coe Co., 16 Burling Slip, New York	E. A. Brown, Middletown.
441	Crocker's New Rival Ammoniated Superphosphate	Crocker Fert. and Chemical Co., Buffalo, N. Y.	Geo. A. Weaver Co., Newport.
485	Crocker's Ammoniated Wheat and Corn Phosphate	Crocker Fert. and Chemical Co., Buffalo, N. Y.	L. S. Bosworth & Son, Barrington.
442	Cumberland Concentrated Phosphate	Cumberland Bone-Phosphate Co., Portland, Me.	C. H. White, Tiverton 4-Corners.
527	" Superphosphate	Cumberland Bone-Phosphate Co, Portland, Me.	Hoxie Bros. Co., Phenix.
461	Darling's Animal Fertilizer	L. B. Darling Fert. Co., Pawtucket, R. I.	H. C. Anthony, Portsmouth.
533	" " " G. Brand.	" " " " "	J. V. Baker, Wickford.
534	" Extra Bone Phosphate	" " " " "	" " "
464	" Fertilizer for Gardens and Lawns	" " " " "	W. E Barrett & Co, Providence.

Sample No.	Name of Brand.	Water.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
433	Clark's Cove Fert. Co 's Great Planet "A" Manure.	11.14	1.56	....	2.00	**3.56**	*3.30*	4.55	4.20	2.11	**10.86**	*9.*	**8.75**	*8.*	**7.45**	*7.*	*	*$28.91*
530	Clark's Cove Fert. Co.'s King Philip Alkaline Guano.	7.16	....	....	1.22	**1.22**	*1.03*	4.82	3.56	2.37	**10.75**	*9.*	**8.38**	*8.*	**2.26**	*2.*	*	*16.71*
502	Clark's Cove Fert. Co.'s Potato and Tobacco Fertilizer.	11 18	.15	....	2.11	**2.26**	*2.06*	5.05	3.65	2.38	**11.08**	*9.*	**8.70**	*8.*	**3.82**	*3.*	*	*21.88*
517	Coe's Alkaline Bone.	9.62	...	....	1 60	**1.60**	*1.00*	7.60	1.51	2.84	**11.95**	*11.*	**9.11**	*9.*	**2.31**	*1.85*	.44	*19.54*
492	Coe's High Grade Ammoniated Bone Superphosphate.	11.52	....	....	2.16	**2.16**	*2.00*	7.61	1.26	2.67	**11.54**	*11.*	**8.87**	*9.*	**1.87**	*1.85*	*	*20.40*
424	Coe's Red Brand Excelsior Guano.	8.20	...	1.29	2.32	**3.61**	*3.50*	9 49	.79	.43	**10.71**	*10.*	**10.28**	*9.*	**5.90**	*6.*	.10	*31.03*
441	Crocker's New Rival Ammoniated Superphosphate.	5.99	....	....	1.41	**1.41**	*1.20*	6.74	3.64	.79	**11.17**	*11.*	**10.38**	*10.*	**1.91**	*1.6*	*	*18.78*
485	Crocker's Ammoniated Wheat and Corn Phosphate.	11.83	....	....	2.19	**2.19**	*2.00*	7.18	2.56	1.75	**11.49**	*11.*	**9.74**	*10.*	**2.35**	*1.6*	.10	*21.81*
442	Cumberland Concentrated Phosphate.	8.06	1.45	...	1.95	**3.40**	*3.30*	4.69	2.84	1.13	**8.66**	*10*	**7.53**	*8.*	**7.04**	*7.*	2.10	*26.96*
527	Cumberland Superphosphate.	14.00	....	....	2.47	**2.47**	*2.00*	7 14	1.84	1.09	**10.07**	*10.*	**8.98**	*8.*	**2.80**	*2.*	*	*21.70*
461	Darling's Animal Fertilizer.	7.96	....	....	3.54	**3.54**	*3.00*	2.52	3.06	4.36	**9.94**	*10.*	**5.58**	*6.*	**5.34**	*4.*	1 60	*25.10*
533	Darling's Animal Fertilizer, G. Brand.	6.24	.24	....	2.81	**3.05**	*2.03*	2.58	3.58	2.72	**8.88**	*7.*	**6.16**	....	**5.59**	*4.*	*	*23.15*
534	Darling's Extra Bone Phosphate	6.00	.70	....	1.19	**1.89**	*2.47*	6.27	2.72	1.11	**10.10**	*10.*	**8.99**	*7.*	**5.40**	*2.*	*	*21.85*
464	Darling's Fertilizer for Gardens and Lawns.	10.68	1.86	...	1.88	**3.74**	*4.00*	3.42	3.18	4.36	**10.96**	*10.*	**6.60**	....	**5.00**	*5.*	1.90	*26 00*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
483	Great Eastern General	Great Eastern Fert. Co., Rutland, Vt	J. Q. A. Gardiner, Barrington.
519	" " " Buckwheat and Seeding Down Phosphate	" " "	R. K. Hoxie & Son, Carolina.
518	Great Eastern General Garden Special	" " "	" " " "
489	Mapes' Complete Manure, "A" Brand	Mapes Formula and Peruvian Guano Co., New York	Chas. H. Martin, Barrington.
539	" " " for General Use	Mapes Formula & Peruvian Guano Co., New York	James C. Goff, Providence.
540	" " " for Light Soils	Mapes Formula & Peruvian Guano Co., New York	" " "
440	Mitchell's Complete Fertilizer	Mitchell Fert. Co., Tremley, N. J	Geo. A. Weaver Co., Newport.
445	" Special Potato Fertilizer	" " " "	Wilbur & Wood, Little Compton.
444	National Fert. Co.'s Chittenden Ammoniated Bone Phosphate	National Fert. Co., Bridgeport, Conn	Albert Peckham, Little Compton.
472	National Fert. Co.'s Chittenden Fish and Potash.	" " " " "	Seth Paull, Bristol.
452	Pacific Guano Co.'s High Grade General	Pacific Guano Co., Box 1368, Boston	D. D. Gifford, Portsmouth.
512	" " " Soluble Pacific Guano	" " " " " "	T. C. Peckham, Coventry.
419	Parmenter & Polsey's Plymouth Rock Brand Fertilizer	Parmenter & Polsey, Peabody, Mass	Wm. G. Rose, Slocumville.
532	Parmenter & Polsey's Star Brand Superphosphate	" " " "	V. V. Hart, Davisville.

Sample No.	Name of Brand.	Water.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
483	Great Eastern General	14.31	....	....	3.00	**3.00**	*2.88*	5 88	1.82	1.61	**9.31**	*9*	**7.70**	*8.*	**2.46**	*2.*	*	*$21.82*
519	Great Eastern General, Buckwheat and Seeding Down Phosphate	12.39	....	....	1 16	**1.16**	*.82*	6.63	1.65	.72	**9.00**	*9.*	**8.28**	*8.*	**4.07**	*4.*	*	*17.55*
518	Great Eastern General, Garden Special	9 98	....	....	3.25	**3.25**	*3 30*	5 16	1.79	1.14	**8.09**	....	**6.95**	*6.*	**8.16**	*8.*	*	*26.69*
489	Mapes' Complete Manure, "A" Brand	10.80	.62	.38	1.76	**2.76**	*2.40*	7.23	3 90	2.07	**13.20**	*12.*	**11.13**	*10.*	**3.27**	*2.5*	*	*25 81*
539	Mapes' Complete Manure for General Use	9.18	.85	.51	2.16	**3.52**	*3.30*	5.01	2.52	2.47	**10.00**	*10.*	**7.53**	*8.*	**5.53**	*4.*	*	*26.31*
540	Mapes' Complete Manure for Light Soils	7.71	1.17	1.13	2.76	**5.06**	*5.00*	2.87	3.81	2.53	**9.21**	*8.*	**6.68**	*6.*	**6.79**	*6.*	*	*31.56*
440	Mitchell's Complete Fertilizer	9.12	1.24	...	2.47	**3.71**	*3.00*	5.95	2.28	1 61	**9.84**	*9.*	**8.23**	*8.*	**5.88**	*6.*	.42	*28.25*
445	Mitchell's Special Potato Fertilizer	6.63	2 21	....	2.29	**4.50**	*4.00*	3.33	1.20	2.12	**6.65**	*8*	**4.53**	*8.*	**8.60**	*8.*	.80	*29.22*
444	National Fert. Co.'s Chittenden Ammoniated Bone Phosphate	13.06	....	....	2.07	**2.07**	*1.65*	2.12	8 18	1.74	**12.04**	*9*	**10.30**	*7.*	**2.35**	*2.*	*	*21 18*
472	National Fert. Co.'s Chittenden Fish and Potash	8.67	....	....	2.35	**2.35**	*2.50*	.50	3.83	3.79	**8.12**	*6.*	**4.33**	..	**3.81**	*3.*	*	*17 51*
452	Pacific Guano Co.'s High Grade General	8.10	1.26	....	2.49	**3.75**	*3 25*	4.57	3.64	1.92	**10.13**	*9.*	**8.21**	*8.*	**7.00**	*7.*	*	*28.55*
512	Pacific Guano Co.'s Soluble Pacific Guano	13.46	....	...	2.30	**2.30**	*2.25*	7.32	1.61	1.78	**10.71**	*10.5*	**8.93**	*8.5*	**2.66**	*2.*	*	*21.25*
419	Parmenter & Polsey's Plymouth Rock Brand Fertilizer	12.85	....	.22	3.09	**3.31**	*3.29*	4.34	4.77	1 84	**10.95**	*9.*	**9.11**	*8.*	**4.74**	*4.*	*	*26.46*
532	Parmenter & Polsey's Star Brand Superphosphate	11 76	....	....	2.10	**2.10**	*1.65*	2.71	5 62	1.46	**9.79**	*8*	**8.33**	*7.*	**2.77**	*2.5*	*	*19.44*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
537	Peters' Sheep Fertilizer	John J. Peters, 39 Borden Ave., Long Island City	Walter A. Potter & Co., Providence.
506	Quinnipiac Climax Phosphate	The Quinnipiac Co., 92 State St., Boston	R. F. Brooks, Harrisville.
505	" Corn Manure	" " " "	" " "
474	" Market Garden Manure	" " " "	Seymour Bros., Warren.
493	" Phosphate	" " " "	H. R. Segar, Westerly.
513	Read's Fish, Bone and Potash	Read Fert. Co., New York	John F. James, Moosup Valley.
525	" High Grade Farmers Friend	" " "	Hoxie Bros. Co., Phenix.
515	" Standard Phosphate	" " "	John F. James, Moosup Valley.
481	Standard Fert. Co.'s Standard Fertilizer	Standard Fert. Co., State St., Boston	A. C. Gardiner, Barrington.
439	" " " " Guano	" " " "	Geo. A. Weaver Co., Newport.
422	Wilcox's Ammoniated Bone Phosphate	Leander Wilcox, Mystic, Conn	E. E. Kenyon, Usquepaug.
423	" Complete Bone Superphosphate	" " " "	" " "
494	" Fruit, Vine and Vegetable Manure	" " " "	F. P. Babcock, Westerly.
426	Williams & Clark's Ammoniated Bone Superphosphate	Williams & Clark Fert. Co., 92 State St., Boston	Albert L Chace, Middletown.

Sample No.	Name of Brand.	Water.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
537	Peters' Sheep Fertilizer........	32.19	....	....	2.53	**2.53**	....	...	...	......	**1.87**	....	......	....	**1.81**	....	...	[3]$*12.12*
506	Quinnipiac Climax Phosphate..	12.12	....	....	1.12	**1.12**	*1.03*	4.03	4.78	2.42	**11.23**	*9.*	**8.81**	*8.*	**2.21**	*2.*	*	*16.75*
505	" Corn Manure.......	12.72	....	....	2.18	**2.18**	*2.06*	3.76	5.14	3.51	**12.41**	*10.*	**8.90**	*9.*	**1.75**	*1.5*	*	*20.34*
474	" Market Garden Manure......................	10.59	1.51	....	2.25	**3.76**	*3.30*	4.85	2 79	2.29	**9.93**	*9.*	**7.64**	*8.*	**7.16**	*7.*	*	*28.20*
493	Quinnipiac Phosphate..........	12.75	.51	....	2.10	**2.61**	*2.47*	7.01	3.06	1.98	**12.05**	*10.*	**10.07**	*9.*	**2.36**	*2.*	*	*23.15*
513	Read's Fish, Bone and Potash..	12.58	....	....	3.67	**3.67**	*2.47*	3 31	1.30	.72	**5.33**	*5.*	**4.61**	*4.*	**6.27**	*4.*	*	*23.44*
525	" High Grade Farmer's Friend.....................	10.43	...	....	3.21	**3.21**	*3.30*	4.45	1.13	.56	**6.14**	....	**5.58**	*5.*	**10.63**	*10.*	*	*26.97*
515	Read's Standard Phosphate....	13.55	....	....	1.00	**1.00**	*.82*	6.47	2.13	.78	**9.38**	*10.*	**8.60**	*8.*	**4.43**	*4.*	*	*17.71*
481	Standard Fert. Co.'s Standard Fertilizer..................	13.39	....	...	2.65	**2.65**	*2.00*	7.18	1 76	1.38	**10.32**	*10.*	**8.94**	*8*	**2.73**	*2.*	*	*22.31*
439	Standard Fert. Co.'s Standard Guano	6.75	....	....	1.00	**1.00**	*1.00*	4.14	4.91	2.41	**11.46**	*10.*	**9.05**	*8.*	**2.41**	*2.*	*	*16.80*
422	Wilcox's Ammoniated Bone Phosphate.....................	16.68	.44	.33	2 34	**3.11**	*2.50*	4.03	2.61	1 29	**7.93**	*7.*	**6.64**	*6.*	**5.33**	*5.*	3.26	*23.45*
423	Wilcox's Complete Bone Superphosphate..................	14.93	.36	....	2.17	**2.53**	*2.00*	5.50	3.62	.96	**10.08**	*9.*	**9.12**	*8*	**3.48**	*3.*	*	*22.34*
494	Wilcox's Fruit, Vine and Vegetable Manure..............	12.27	1.22	....	2.33	**3.55**	*3.00*	4.43	2.36	1 13	**7.92**	*7.*	**6.79**	*6.*	**10.18**	*10.*	5.06	*29.42*
426	Williams & Clark's Ammoniated Bone Superphosphate.......	13.80	.48	...	2.17	**2.65**	*2.47*	5.97	3.85	1.77	**11.59**	*10.*	**9.82**	*9.*	**2.69**	*2.*	*	*23.13*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

[3] The nitrogen in this fertilizer was valued at 16½, phosphoric acid at 5 and potash at 5¼ cents per pound.

THE EFFECT OF LIMING UPON THE DEVELOPMENT OF POTATO TUBERS.

H. J. WHEELER, J. D. TOWAR AND G. M. TUCKER.

In a previous publication[1] attention was called to an observation by Heiden in Germany and to others at this Station, showing that the use of lime exerted an effect upon the relative yield of large and small tubers. Owing to the fact that soils in many sections of the State had been found to show a considerable degree of acidity, from which it appeared probable that a more general use of lime or wood ashes would be desirable, it was deemed important to make further observations in the same line. Accordingly, in 1894, a considerable number of experiments were conducted, which throw additional light upon this point, as follows: (1) Results obtained from the soda substitution experiment. A plan of these plots, viz.: 1 to 48 inclusive, showing their general arrangement and the fertilizers applied, may be found in the Seventh Annual Report of the Rhode Island Agricultural Experiment Station, p. 175. Only the results on the two plots arranged on the same horizontal line are directly comparable, owing to the fact that variations in manuring other than those due to lime exist between the plots as vertically arranged. Upon these plots which were limed, air-slacked lime was applied in 1894 at the rate of two tons per acre. The results recorded are from one row of potatoes across each plot.

(2) The results secured from Plot 15 were obtained upon small sub-divisions of a portion of the plot, each of which was 18 x 30 feet in size. Seed tubers, treated with corrosive sublimate solution for the destruction of scab germs, were alternated, in groups of two and three rows, with untreated seed. Dissolved boneblack and muriate of potash were applied to each plot at the rates of

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[1] Sixth Annual Report R. I. Agrl. Expt. Station, 1893, pp. 242 and 243.

600 and 200 pounds per acre respectively. Where nitrate of soda was used in addition, it was at the rate of 472.4 pounds per acre, and the dried blood and Pennsylvania tankage[1] were applied in such quantities as to furnish the same amount of nitrogen per acre. The limed plots received air-slacked lime at the rate of two and one-half tons per acre in 1893, and at the rate of one-half ton additional in 1894.

(3) Numbers 27 and 29 of the permanent experimental plots were each manured in 1893 and 1894 as follows: Dissolved bone-black, 600 pounds; muriate of potash, 200 pounds; and sodium nitrate, 465 pounds per acre. Plot 27 received no lime, but Plot 29 received in 1893 air-slacked lime at the rate of 5,400 pounds per acre, and in 1894 a further application at the rate of one-half ton per acre.

The results of the experiments are embodied in the following table:

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[1] Some form of treated leather waste mixed with material resembling dried and fine ground city garbage.

Table Showing the Total Weights and Proportion of Large and Small Potato Tubers upon Limed and Unlimed Soil. (Weights in pounds.)

	LIMED.						UNLIMED.					
	No. of Plot or Section.	Total Weight of Tubers.	Weight of Large Tubers.	Weight of Small Tubers.	Per cent. of Large Tubers.	Per cent. of Small Tubers.	No. of Plot or Section.	Total Weight of Tubers.	Weight of Large Tubers.	Weight of Small Tubers.	Per cent. of Large Tubers.	Per cent. of Small Tubers.
Results obtained in connection with the "Soda Substitution" experiment. Plots 1 to 48 inclusive*	13	10.9	8.9	2.0	81.7	18.3	1	13.3	9.0	4.3	67.7	32.3
	14	11.7	7.8	3.9	66.7	33.3	2	10.4	7.3	3.1	70.5	29.5
	15	9.4	8.0	1.4	85.1	14.9	3	11.4	8.1	3.3	71.1	28.9
	16	8.5	5.8	2.7	68.2	31.8	4	8.9	5.1	3.8	57.3	42.7
	17	12.0	9.4	2.6	78.3	21.7	5	11.2	8.1	3.1	72.3	27.7
	18	10.6	8.2	2 4	77.4	22.6	6	14.7	10.8	3.9	73.5	26.5
	19	13.1	10.9	2.2	83.2	16.8	7	9.8	6.1	3.7	62.3	37.7
	20	12.2	10.1	2.1	82.8	17.2	8	11.5	8.2	3.3	71.3	28.7
	21	12.6	9.5	3.1	75.4	24.6	9	12.5	9.2	3.3	73.6	26.4
	22	11.1	8.2	2.9	73.9	26.1	10	9.4	6.6	2.8	70.2	29.8
	23	11.2	8.9	2.3	79.5	20.5	11	13.5	10.1	3.4	74.8	25.2
	24	11.8	8.9	2.9	75.4	24.6	12	13.5	9.2	4.3	68.1	31.9
	37†	7.3	4.4	2.9	60.3	39.7	25†	11.9	9.4	2.5	79.0	21.0
	38	10.1	9.1	1.0	90.1	9.9	26	9.9	6.5	3.4	65.7	34.3
	39	11.9	9.8	2.1	82.4	17.6	27	9.9	6.7	3.2	67.7	32.3
	40	10.8	8.4	2.4	77.8	22.2	28	7.8	4.1	3.7	52.6	47.4
	41	10.4	6.8	3.6	65.4	34.6	29	9.9	7.0	2 9	70.7	29.3
	42	9.8	6.6	3.2	67.3	32.7	30	12.6	9.0	3.6	71.4	28.6
	43	9.8	6.9	2.9	70.4	29.6	31	6.5	2.2	4.3	33.8	66.2
	44	12.5	10.1	2.4	80.8	19.2	32	11.8	7.3	4.5	61 9	38.1
	45	11.3	8.5	2.8	75.2	24.8	33	10.7	6.9	3.8	64.5	35.5
	46	9.1	7.3	1.8	80.2	19.8	34	12.9	9.6	3.3	74.4	25.6
	47	10.6	7.4	3.2	69.8	30.2	35	10.3	6.8	3.5	66.0	34.0
	48	8.6	4.8	3.8	55.8	44.2	36	11.1	8.6	2.5	77.5	22.5
Plot 15, tubers treated with Corrosive Sublimate Solution	d2	88.6	68.8	19.8	77.7	22.3	d1	67.6	39.6	28.0	58.6	41.4
	c2	77.8	54.8	23.0	70.4	29.6	c1	66.0	49.5	16.5	75.0	25.0
	b2	62.9	40.0	22.9	63.6	36.4	b1	62.6	32.5	30.1	51.9	48.1
Plot 15, tubers untreated with Corrosive Sublimate Solution	d2	92.3	64.0	28.3	69.3	30.7	d1	58.5	24.4	34.1	41.7	58.3
	c2	64.5	42 5	22.0	65.9	34.1	c1	59.8	27.3	32.5	45.7	54.3
Permanent Plots, 29 and 27, tubers treated with Corrosive Sublimate Solution	29	27.8	23.4	4.4	84.2	15.8	27	16.3	9.6	6.7	58.9	41.1
Permanent Plots, 29 and 27, tubers untreated with Corrosive Sublimate Solution	29	9.3	4.9	4.4	52.7	47.3	27	8.1	2.3	5.8	28.4	71.6

* These weights were obtained after the tubers had been washed and were taken a few weeks later than the field weights given in the 7th Annual Report of this Station, pages 179, 180, which explains why they are slightly less.

† Omitted from the averages owing to the fact that the total weights recorded in the case of Plot 25 is greater than the field weight, showing that some error in the weights from this plot must have been made.

Owing to the fact that the same quantities of lime were not used in each group of experiments, and also to the variations in manuring between the plots as vertically arranged, each pair of plots as arranged horizontally represents in reality a distinct experiment, for which reason the percentage of large and small tubers has been calculated for each independently, instead of from the sums or averages of the total, large and small tubers, which would otherwise have been the method for obtaining a general average. If all the percentages thus obtained are averaged, we find the following result:

	Per cent. Large[1] tubers.	Per cent. Small tubers.
With lime	74.2	25.8
Without lime	63.3	36.7

In the experiments on plots 1 to 48 the total yield was not increased by liming, but, with few exceptions, the percentage of large tubers was increased. In other experiments the total yield was also increased apparently as a result of the liming. It will be obvious that a gain of ten per cent. in large tubers by the use of lime would be a factor of considerable financial importance, provided there were no drawbacks in the way of its attainment. Such a drawback has been met with, as previously shown,[2] owing to the tendency of lime to increase the potato scab. It has been hoped that by treating the seed tubers with corrosive sublimate solution[3] before planting, the germs of the disease might thus be destroyed, and if the crop were then grown upon a soil not already contaminated with the germs, a product free from the scab might be procured. Such evidence as has thus far been secured indicates, however, that a few germs may escape the corrosive sublimate treatment, and in consequence the danger to succeeding crops of potatoes will be increased by the use of lime. Prof. H. L. Bolley of North Dakota, the author of the treatment, claims it to be in this respect *fully effectual.* It seems safer, however, at present, until Bolley's position is shown to be right, and in view of our own experience, to caution our Rhode Island farmers in regard to the use of lime upon lands where potatoes are to be grown. The experience thus far secured at this Station prompts us to give the following general advice until such a time as some of the questions involved can be definitely settled.

[1] Single tubers weighing 2 oz. or more were classed as large.
[2] Bulletin 26, R. I. Agrl. Expt. Station, p. 141, also Bull. 30, p. 66.
[3] For the method of treatment see Bull. 26, R. I. Agrl. Expt. Station, p. 155.

GENERAL SUMMARY AND ADVICE.

1. Upon our sour or acid soil, which contains probably no calcium carbonate, potato tubers practically free from the scab may be grown, even if the seed tubers are infested with the germs of the disease, provided commercial fertilizer and not barnyard manure is employed.

2. On soil which is not acid, or where barnyard manure or lime in forms other than land plaster (gypsum) is frequently employed, all seed tubers should be treated with corrosive sublimate solution before planting. Under such circumstances crops of potatoes should not follow each other at close intervals, or the damage from the scab may be increased.

3. If the character of the land is unknown, all seed tubers should be subjected to the corrosive sublimate treatment, even when commercial fertilizers are employed, provided one wishes to secure a smooth crop.

4. On sour or acid soil a gain in total yield of potato tubers may result from the use of air-slacked lime, and our own experiments show a decided gain in the percentage of tubers of merchantable size.

5. If lime is to be used on acid land where potatoes are to be grown, it should not be employed in quantities greater than one to one and one-half tons per acre at a single aplication, and the rotation should be so arranged that two or three crops intervene between the time of liming and the growing of the potatoes. A good arrangement would be to lime before rye, Indian corn, oats or barley, and then follow with clover before the potatoes.

6. It may be possible by such an arrangement on acid soils, provided the corrosive sublimate treatment of the seed tubers is employed, that much of the benefit upon the potato crop from liming, and also practical immunity from the potato scab may be enjoyed.

Upon the Effect of Barnyard Manure and Various Compounds of Sodium, Calcium and Nitrogen Upon the Development of the Potato Scab.

H. J. WHEELER AND G. M. TUCKER.

For the benefit of any readers who are not already familiar with the full history of the potato scab, we will give a brief statement of what has been learned in relation to it, in order that a more complete understanding of our experiments will be possible.

Formerly the disease known as the potato scab was generally supposed to be due to an injury to the surface of the tubers, caused *directly* by insect attacks, the presence of irritating substances in the soil or manures, or to an excess of moisture. The scab was supposed to result from the attempt to repair the injury, in a manner similar to that in which a tree tries to cover once more a spot where the bark has been removed. In 1890 H. L. Bolley claimed to have found an organism, a minute plant, which was capable, by its growth upon the tuber, of producing potato scab, but from later experience he has become convinced that the chief cause of the scab is not the organism studied by him, but rather another (Oospora scabies), which was discovered by R. Thaxter at about the same time. At a more recent date A. D. Hopkins discovered a small gnat which, it is claimed, will attack the uninjured surface of potato tubers, producing an injury in appearance practically like that produced by the organism discovered by Thaxter. Just how much damage may be attributable to this gnat or to other insects cannot be stated, yet, owing to the fact that in seasons and places where the scab disease is prevalent but

few or none of the gnats have been found,[1] it appears probable that the chief cause of the scab is that which seems now to be generally accepted, viz.: the bacteroid fungus discovered by Thaxter. The direct cause of the scab having been recognized, the idea of destroying the germs of the disease upon the seed tubers with the hope of preventing their introduction into the soil, next suggested itself. The idea of disinfecting both soil and tubers by spraying the seed tubers in the row with Bordeaux mixture was also tried by L. F. Kinney. Various methods of treatment of the seed tubers for the accomplishment of the above mentioned object have been resorted to by various experimenters, but the treatment proposed by Bolley, viz.: that with corrosive sublimate solution as described in BULLETIN No. 26 of this Station, page 155, has shown itself to be the most satisfactory of any yet resorted to. In fact the cost of the material required for the treatment of several bushels of seed tubers amounts to but a few cents, and the results secured upon most soils have been so excellent that no grower of potatoes who uses lime, wood ashes, or barnyard manure, or who finds that his soil is already in such a condition that upon the introduction of the germs, a scabbed crop results, should fail to resort to the treatment at once.

As an immediate consequence of the recognition of the direct cause of the scab disease, the influence of fertilizers and soil upon its development was finally publicly denied by Bolley,[2] and statements to the same effect became extensively quoted by other Station writers and by the agricultural press. In 1893 it was observed at this Station in experiments conducted for another purpose, that where the seed tubers had not been treated with corrosive sublimate solution and where air-slacked lime had been used, the percentage of scabbed tubers had been decidedly increased.[3] In 1894 a large number of experiments confirmed this observation,[4] showing conclusively, notwithstanding that the lime of itself does not produce the scab, that it does in some way favor the growth and development of the disease germs upon the potato

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1 We have endeavored to find these gnats, and did succeed in finding larvæ and adults of some insect which we submitted to Prof. A. D. Hopkins of W. Va., who diagnosed them as rove beetles, *Homalota lividipennis*, which he does not consider as in any way connected with the cause of the scab.

2 Bull. 9, North Dakota Agrl. Expt. Station, p. 31.

3 Bull. 26, R. I. Agrl. Expt. Station, p. 141.

4 Bull. 30, R. I. Agrl. Expt. Station, p. 66.

tubers. Such a result having been anticipated from the observations made in 1893, experiments were conducted in 1894 upon plots 15, 23, 25, 27 and 29, to test whether the corrosive sublimate treatment would destroy all of the germs upon seed tubers and thus furnish total immunity from the scab upon a soil not yet contaminated with them. Prior to that time Bolley had shown that the scab of beets is identical with that of potatoes, and therefore, beets were grown in the four last-mentioned plots between the potato hills with the expectation that if germs of the disease did not *already exist in the soil*, the beets would not become scabbed, while if the potatoes were affected strong evidence would be furnished that the germs of the disease were introduced upon the seed tubers. In fact such was the actual result where untreated tubers were employed, and strong circumstantial evidence was thus furnished that in the row grown from treated seed a few germs had escaped destruction. The treatment was continued for one and one-half hours with a solution of one part of corrosive sublimate in 1,000 parts of water. Where potatoes had been grown the previous year, the beets between the potato hills were invariably covered with scab upon the limed plots, showing that the germs had remained in the soil from the previous season.

On plot 15 beets were not grown between the potato hills, yet they had been grown on several other plots taken from the same original grass field, and in no case had they or have they even to the present time, ever shown any trace of scab[1] even on limed plots except as heretofore stated, viz.: where the soil had been previously contaminated by a potato crop. It is therefore probable that the soil in this case was wholly free from the germs of the disease, and in consideration of the fact that the treated tubers on the limed section of the plot produced a more or less scabbed crop, further evidence was furnished that a few germs had escaped destruction by the treatment. From other results secured last season it was evident, where the germs of the disease were once introduced into a soil favorable to their development, that they multiplied rapidly, for the second crop of potatoes upon this soil was so scabby as to be practically worthless for market purposes. It having been ascertained that the addition of considerable lime to our acid soil rendered it favorable to the development of the disease, it will at once be evident that

[1] This finds its explanation on the ground that the beet seed and soil were free from scab germs.

if the treatment of the seed tubers does not destroy all of the germs, sufficient may be introduced, notwithstanding this precaution, to cause serious injury to succeeding crops. In view of all these circumstances it seemed imperative to caution our Rhode Island farmers against the use of considerable dressings of lime or wood ashes upon fields intended for the cultivation of potatoes either successively or in frequent rotation, until some *absolutely* effectual method of treatment is discovered. It will be seen that in making such a recommendation, a doubt was cast upon the ability of the corrosive sublimate treatment to *destroy absolutely every germ* upon seed tubers, though in a general way the treatment was highly recommended and its use encouraged. Had we stated unconditionally that lime could be used with impunity on soils not previously contaminated with the germs, provided the corrosive sublimate treatment of the seed tubers was resorted to and proper care taken to avoid contamination from other sources, it appeared probable that some germs might escape destruction and the final results prove disastrous. Notwithstanding these considerations, however, Bolley has not only taken our position to be one antagonistic to his treatment, but has stated that the conditions under which our experiments were carried out were such that the evidence afforded by them cannot be considered as good.[1] He further states in a private communication that he has "never failed, in four years, to destroy all scab fungus upon the most deeply scabbed seed tubers." The point which we have claimed was based upon the circumstantial evidence afforded by our experiments to the effect that all the germs were not destroyed by his treatment. The time of treatment which Bolley recommends is one and one-half hours, and in Bulletin 4 of the North Dakota Station, page 14, he recommends the use of 2 ozs. of corrosive sublimate to fifteen gallons of water, which gives a solution of about 1 to 1,000. In Bulletin 9 of the same Station, he recommends two and one-fourth ounces to the same amount of water or a stronger solution, but nevertheless states on page 30 of the same bulletin that the spore bodies "are destroyed by contact with a 1 to 1,000 solution of corrosive sublimate in a comparatively short time." The strength of solution employed by us was 2 ozs. to fifteen gallons of water, and the treatment was continued one and one-half hours, which, in view of the above-mentioned statements

[1] Bull. 19, No. Dakota Agrl. Expt. Station, p. 131.

and directions, was supposed to be all that was considered necessary for the accomplishment of the object; and this treatment must have met all the requirements of the case, if, as Bolley states, he has never failed to destroy all scab fungus upon the most deeply scabbed seed tubers, for apparently the strength of solution was the same as that used by him in a portion of his work. In support of our own results, which indicate that some germs may escape destruction by the treatment, and also that the strength of solution employed by us could not be used as an argument against our results, we cite the following experience of others, viz.: L. R. Taft, of the Michigan Station,[1] states that "Corrosive sublimate, 1 part to 2,000 seems to be as effective as 1 part to 1,000. He also states[2] that soaking the seed longer than one and one-half hours may lessen the scab still more, but it reduces the yield." C. F. Curtis, of the Iowa Station,[3] found, when using a solution containing *two and one-quarter ounces of corrosive sublimate to 15 gallons of water*, that a treatment for two hours produced less scab in the product than a treatment for one and one-half hours. J. E. Arthur, of the Indiana Station,[4] reports results secured in 1893 with corrosive sublimate solution made of a strength of 1 to 1,000, in which a treatment for two hours was more effective than that for one and one-half hours. James Troop, of the Indiana Station,[5] has tabulated the results of three of his experiments in which by the use of a solution of 1 to 1,000 the percentage of scab was in every case decreased by extending the treatment from one and one-half to three hours. Y. P. Clinton, of the Illinois Station,[6] is also of the opinion that a treatment of three hours is more effective than one of an hour and a half. It will be seen from the above results, that the circumstantial evidence afforded by our own experiments has received strong confirmation from several sides, justifying, therefore, in opposition to Bolley's criticism, the position which we took when we deemed it questionable if the treatment with corrosive sublimate, as directed by him, was sure to destroy all of the germs upon the seed tubers. It is also at least significant to note that Bolley in his latest publication[7] recom-

[1] Bull. 108, p. 44.
[2] l. c.
[3] Bull. 27, p. 126.
[4] Bull. 56, pp. 72 and 73.
[5] Bull. 53, p. 122.
[6] Bull. 40, p. 144.
[7] Bull. 19, No. Dakota Agrl. Expt. Station, p. 132.

mends the use of ten ounces of corrosive sublimate to 60 gallons of water, or in other words, a solution much stronger than either of those employed in his previous work, notwithstanding his statement that the solutions previously employed by him never failed to destroy all of the germs.[1]

THE DEVELOPMENT OF THE SCAB AS AFFECTED BY SOILS AND MANURES.

As before stated, the results secured in experiments at this Station in 1893 and 1894 showed distinctly that the character of the soil and manures is an important factor in preventing or promoting the development of the scab when germs are once introduced on seed tubers or by other means, even when the soils and manures are themselves free from the germs of the disease. It must therefore be apparent that the recognition of soil characters which are favorable or unfavorable, and also the influence of various manures in this respect, must be a matter of no little importance, particularly in the older potato growing regions where the germs of the disease are more generally distributed. This is strongly emphasized in view of the fact that Bolley and other experimenters are well united in the opinion that in a soil already contaminated, even the corrosive sublimate treatment cannot prevent scabbiness in the crop, and our own experiments show this to be especially true in a soil highly favorable to the disease.

Since the publication of our own observations in this direction the subject has been studied to some extent by others. James Troop[2] grew potatoes from the same lot of untreated seed tubers on presumably uncontaminated muck and sandy loam soils, and found that a much greater percentage of scab resulted in the former case. Doubtless the soils were free, or at least nearly equally free from the scab, as shown by the fact that where the seed tubers were treated with corrosive sublimate for like lengths of time, differences of over 3.75 per cent. in the scabbiness of the product were in no case noted, while where the untreated seed tubers were used, the difference in the per cent. of scab on the two soils amounted to from 40 to 43 per cent., showing conclu-

[1] It is possible that this change was suggested for use on a large scale on the basis of the work of Taft and Kedzie, who have shown that the strength of the solution gradually diminishes with use, and not owing to a belief that its efficiency was not absolute when using the weaker solution.

[2] Bull. 53, Indiana Agrl. Expt. Station, Dec., 1894, pp. 121-122.

sively that the character of the soils, aside from any germs they may have contained, exerted a powerful influence upon the development of the scab upon the tubers. Wm. C. Sturgis claims[1] that barnyard manure is conducive to the development of the scab, though owing to the fact that it was unknown whether the germs of the disease were present in the manure or not, and if so to what extent, *the results afford no information as to whether or not the manure if free from disease germs would have had such an influence.* F. Wm. Rane also cites results[2] to show that lime and barnyard manure increased the scab in tubers, though whether this was due to disease germs in the barnyard manure or to the effect of the manure itself, it is impossible to determine. As will be seen, the results by Troop and those by Rane, with lime, agree with the observations made at this Station, viz.: to the effect that the character of the soil and fertilizers, even if they are themselves practically or even entirely uncontaminated, does exert a decided influence upon the development of the scab when the germs are introduced on seed tubers or from other sources. Our own experiments with air-slacked lime suggested a number of possibilities as to how this result might be brought about, which may be summarized as follows: (1) Possibly to some extent owing to its having increased the water capacity of the soil, whereby the development of the germs upon the seed tubers was facilitated, but the enormous differences in scabbiness noticed in the last two years between tubers grown on the limed and unlimed plots and pots, furnish strong circumstantial evidence that this action of the lime is not in any considerable degree accountable for the effect. (2) It is possible that the lime affects the chemical composition of the tubers in such a way as to make them more subject to the attack of the scab fungus. In regard to this point we have had no opportunity to obtain any data. (3) The carbonic acid or the lime when in the form of the carbonate may act as a nutrient to the fungus. That the lime regardless of its form does not exert such an action is shown by the results with calcium chloride and calcium sulphate which are to be enumerated in this bulletin. (4) The lime may decrease or overcome the natural acidity of the soil or decompose compounds in the soil, the existence of one or the other or both of which is antagonistic to the

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[1] 18th An. Rep't Conn. Agrl. Expt. Station, Dec., 1894, pp. 121-122.

[2] Bull. 38, W. Va. Agrl. Expt. Station, Nov., 1894, pp. 45-46.

development of the germs upon the potato tubers which the soil encloses.

It now remains to consider our own observations.

THE COMPARATIVE EFFECT OF AMMONIUM SULPHATE AND SODIUM NITRATE UPON THE DEVELOPMENT OF THE POTATO SCAB WHEN USED IN CONNECTION WITH LIKE QUANTITIES OF MURIATE OF POTASH, DISSOLVED BONE-BLACK AND AIR-SLACKED LIME.

The results secured in this connection are from plots Nos. 23, 25, 27 and 29, which are referred to in Bulletins Nos. 26 and 30 of this Station, in previous discussions of experiments on the potato scab. In 1893, 1894 and 1895, a very marked difference has been noticed in the percentage of scab when comparing the results on plot 23 with those on plot 27. In each case the same amount of nitrogen was used in connection with muriate of potash and dissolved boneblack, without lime, and where ammonium sulphate was the form employed, the crop has remained in most cases free from the scab, while where the nitrate of soda was used, more scab was present. In this case, however, where the ammonium sulphate was used on unlimed acid soil the crop was practically a failure, owing to the poisonous action of the ammonium sulphate upon the plants, when applied under such conditions.

The results which we are now about to enumerate are those obtained where the ammonium sulphate and sodium nitrate were applied to limed soil in connection with the same amounts and forms of potash and phosphoric acid, and where the development of the plants was normal. The total amount of air-slacked lime applied has been as follows, viz.: two and one-half tons per acre in 1893 and one-half a ton additional in 1894, none having been applied in 1895. The first year of the experiment (1893) no particular difference in the percentage of scab was noticeable, but in 1894 the following results were obtained.

(1) By use of treated seed tubers:

	Ammonium sulphate, Per cent.	Sodium nitrate, Per cent.
Free from scab	62.5	50.9
Scabbed	37.5	49.1
Badly scabbed*	5.9	5.3

* Included in the scabbed.

(2) By use of untreated "seed" on a line across the plots where potatoes had not been previously grown:

	Ammonium sulphate, Per cent.	Sodium nitrate, Per cent.
Free from scab	45 3	28.7
Scabbed	54.7	71.3
Badly scabbed	4.2	21.7

(3) By use of untreated seed tubers and grown on the location of a previous potato row of 1893, in which untreated seed tubers were also used:

	Ammonium sulphate, Per cent.	Sodium nitrate, Per cent.
Free from scab	0 0	0.0
Scabbed	100.0	100.0
Badly scabbed	53.9	88.8

It will be seen from the foregoing that in 1894 the three results point to the conclusion that ammonium sulphate when used on limed soil[1] produces less scab than the same amount of nitrogen in form of nitrate of soda, when all other conditions are alike.

The following table shows the results secured in 1895 upon the same plots:

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[1] It is conceivable that if a soil were but slightly acid, neutral or slightly alkaline and an extremely large application of lime, much of which was in a caustic state, were made, it might render the soil so alkaline that it would be unfavorable to the scab, and in such a case the action of ammonium sulphate might be the opposite of that above given, yet such a condition would hardly result in ordinary practice on account of the moderate use of lime.

Table showing the relative effect of Ammonium Sulphate and Sodium Nitrate upon the development of the Potato Scab when each is used in connection with like quantities of Dissolved Boneblack, Muriate of Potash and Air-Slacked Lime.

		Per cent. free from scab.	Per cent. scabbed.	Per cent. badly scabbed.
Ammonium sulphate, Tubers treated*....	On line of row grown from treated "seed" in 1894.	40.0	60.0	28 0
Sodium nitrate, " "		48.0	52.0	24.0
Ammonium sulphate, Tubers untreated...		30.0	70.0	10 0
Sodium nitrate, " " ..		0 0	100.0	75.0
Ammonium sulphate, Tubers treated*....	Near line of row grown from untreated "seed" in 1894.	15.0	85.0	45.0
Sodium nitrate, " "		9.5	90.5	85.7
Ammonium sulphate, Tubers untreated*..		29.2	70.8	45.8
Sodium nitrate, " " ..		0.0	100.0	84.2
Ammonium sulphate, Tubers treated*....	On line of rows grown in 1893 and 1894 from untreated "seed."	14.3	85.7	71.4
Sodium nitrate, " " ...		0.0	100.0	100.0
Ammonium sulphate, Tubers untreated...		0.0	100.0	81 5
Sodium nitrate, " " ..		0.0	100.0	100.0
Ammonium sulphate, Tubers treated*...	On line of row grown in 1894 from untreated "seed."	39.1	60 9	26.1
Sodium nitrate, " "		29.2	70.8	29.2
Ammonium sulphate, Tubers untreated...		54.2	45.8	12.5
Sodium nitrate, " " ..		10.3	89.7	72.4

* With corrosive sublimate solution.

From the foregoing table it will be seen that, with the exception of the case of the treated tubers in the first subdivision of the table, where the differences are not great, the results are in every case in accord with those of 1894, thus still further emphasizing the fact that, on a limed soil which already contains the germs of the disease or which is conducive to their development if introduced, an amount of nitrogen in form of sulphate of ammonia will produce a crop more nearly free from scab than the same amount of nitrogen in form of sodium nitrate. An explanation of this peculiar action of these compounds may perhaps be that some of the ammonium sulphate remains in the soil in an unaltered condition until the tubers attain their development, and that this salt acts as a disinfectant, yet this would hardly seem

possible in view of the rapidity with which the nitrification of ammonium sulphate progresses, under such favorable conditions as would be furnished by the lime. Other experiments which will be cited in the following pages, as well as that by Troop, above mentioned, point to the conclusion that certain soils, at least, act themselves as disinfectants, either due to particular compounds produced within them or to their natural acidity. Our own results in this and previous years point strongly to the conclusion that either the acidity or alkalinity of soils or else the presence of carbonates within them, determines in a great measure the injury which may be expected from potato scab when the germs of the disease are once introduced into them. The difficulty of settling satisfactorily the particular point as to whether it is the presence of carbonates or the reaction of the soil as concerns acidity and alkalinity, will be more readily apparent when we bear in mind that such substances as are capable of counteracting the acidity of soils are either carbonates or are changed into carbonates by natural processes within the soil, subsequent to their application. In consideration of the fact that most Rhode Island soils give an acid reaction of varying degrees of intensity, the practical treatment of our soils, so far as concerns avoiding conditions favorable to the development of the potato scab, seems, therefore, to be settled, and an attempt to pursue the above-mentioned question further would present for us probably nothing of practical but results of scientific interest only.

The above departure from a direct discussion of the results obtained with ammonium sulphate and sodium nitrate seemed desirable, in order to render possible a more perfect understanding of what seems to be the most probable explanation of the smaller percentage of scab where ammonium sulphate was used on limed soil compared with that where sodium nitrate was similarly employed. When sodium nitrate is employed as a fertilizer probably only a small portion of it is taken up by the plant as such, the greater portion of the nitric acid entering into other combinations in the soil, after which it is taken up chiefly in the form of magnesium, potassium and calcium nitrates, and in view of the fact that the residual product in this instance is soda, there could be no tendency toward acidity from its use, but if either, it would be toward an alkaline condition. Where ammonium sulphate is employed in the presence of calcium carbonate, which is the case where air-slacked lime is applied to the soil, the ammonium salt is

decomposed, the ammonia is changed to nitric acid, and this and the residual sulphuric acid enter into new combinations, whereby calcium sulphate (land plaster or gypsum), and nitrates of potash, lime, magnesia, etc., are formed, which are in turn taken up by the plant. By this process it will be seen that the residual product is an acid (sulphuric acid), which combines with other bases in the soil, thereby tending to overcome any basic or alkaline property which it might possess. In the process above outlined the natural result would be to change the calcium carbonate into calcium sulphate or land plaster, and to render the conditions for the development or increase of natural acidity favorable, so that in one or the other or both of these ways the capacity of the soil for favoring the development of the potato scab would be decreased.

THE EFFECT OF THE PRESENCE OF SODIUM CHLORIDE (COMMON SALT), SODIUM CARBONATE AND OXALIC ACID UPON THE DEVELOPMENT OF THE POTATO SCAB, WHEN TUBERS WERE GROWN WITH THE AID OF BARNYARD MANURE.

From the observations upon the effect of lime upon the development of the potato scab in 1893, it seemed probable that the almost universally acknowledged tendency of stable manure to promote its development might be due as much to its alkaline properties and the formation of carbonates during its decomposition, whereby it would render the soil more favorable to the development of the germs upon the tubers, as to its acting as a direct germ bearing medium. That is to say, it seemed probable that even if no disease germs were present in the manure, its presence might cause more scab in the crop than would be produced by the use of commercial fertilizers, provided a like amount of germs was introduced into the soil in each case, and provided also that no germicidal action of the commercial fertilizer resulted. In view of the action of calcium carbonate, which supports the above idea, it seemed desirable to note if other carbonates would also have a similar tendency to promote the scab. Accordingly an experiment in pots was undertaken, with the hope of securing more uniform conditions than were possible in the field, and for the reason that it was desirable to use chemically pure materials, which would be too expensive for trial on a large scale. Galvanized iron ash cans of the same kind, and filled with the same soil

as described in Bulletin 30 of this Station, p. 79, served as pots. Each pot received an application of four pounds of stable manure from the Experiment Station stables in 1894, and three pounds in 1895. The manure was as carefully mixed as possible before it was weighed out, and it was not known whether germs of the scab disease were present in it or not. The weighed portions were thoroughly mixed with the soil of each pot, after which the additional materials, as given in the succeeding tables, were similarly incorporated, prior to planting the untreated scabby tubers. Where oxalic acid was applied it was used at the rate of 20 grams per pot in 1894, and 30 grams per pot in 1895. Common salt (sodium chloride) was applied at the rate of 6.37 grams per pot each year, and sodium carbonate at the rate of 5.53 grams, or so that the soda (sodium oxide) or its equivalent applied in each case would be identical. In 1894 there was much difficulty in securing scabbed seed tubers, so that those which were used were, unlike those of 1895 (*see Fig. 1, showing tubers used in 1895*), but slightly scabbed. In consequence of this but comparatively few germs were probably introduced in this way at the outstart. It is also probable that a considerable difference in the degree of contamination of the soil of the pots resulted for this reason. Owing probably to this, and doubtless more particularly to the additional fact that the quantities of sodium carbonate and common salt employed were too small to produce very decided effects the first season, no conclusions were possible without a repetition of the experiment. Owing to the present imperfect knowledge of the natural acids and acid compounds of the soil, and to the impossibility of imitating the natural soil conditions, oxalic acid was selected for use in the experiment, for the purpose of ascertaining if the acidity thereby produced would have a tendency to reduce the percentage of scab. It was presumed at the outstart that this acid would decompose so rapidly in the soil, probably yielding ultimately carbonic acid and water, that if applied at the time of planting no very marked effect from its application would be noticeable, and the results this season accord with such an idea. If the experiment is continued another year frequent watering with oxalic acid solution will be resorted to, during the period of the development of the potato tubers, and a like amount of pure water will be applied to all other pots. It is hoped that the following tables, which contain the results for 1894 and 1895, will, after this preliminary description, be self-explanatory.

I. Table showing the influence of the presence of sodium chloride (common salt), sodium carbonate and oxalic acid upon the development of the potato scab, when tubers were grown with the aid of barnyard manure.

(First year of the experiment, 1894.)

MATERIALS USED.	No. of pot.	No. of tubers free from scab.	No. of tubers scabbed.	No. of tubers badly scabbed.	Total No. of tubers	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Barnyard manure and common salt, (Sodium Chloride)	67	3	7	2	10	30.0	70 0	20.0
	68	6	8	2	14	42.9	57.1	14.3
	69	1	13	1	14	7.1	92.9	7.1
Barnyard manure	82	5	8	5	13	38.5	61.5	38.5
	83	5	8	2	13	38.5	61.5	15.4
	84	6	9	2	15	40.0	60.0	13.3
Barnyard manure and sodium carbonate	79	9	12	5	21	42.9	57.1	23.8
	80	7	16	8	23	30.4	69.6	34.8
	81	1	11	8	12	8.3	91.7	66.7
Barnyard manure, common salt, and oxalic acid	64	7	7	4	14	50 0	50.0	28.6
	65	1	16	5	17	5.9	94.1	29.4
	66	5	15	5	20	25 0	75.0	25.0
Barnyard manure and oxalic acid	70	4	15	3	19	21.1	79.0	15.8
	71	3	14	8	17	17.7	82 4	47.1
	72	13	7	1	20	65.0	35.0	0.5
Barnyard manure, sodium carbonate and oxalic acid	76	9	7	2	16	56.3	43.8	12.5
	77	5	4	1	9	55.6	44 4	11.1
	78	4	12	7	16	25.0	75.0	43.8

II. Table showing the influence of the presence of sodium chloride (common salt), sodium carbonate and oxalic acid upon the development of the potato scab, when tubers were grown with the aid of barnyard manure.

(Second year of the experiment, 1895.)

MATERIALS USED.	No. of pot.	No. of tubers free from scab.	No. of tubers scabbed.	No. of tubers badly scabbed.	Total No. of tubers.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Barnyard manure and common salt, (Sodium Chloride)	67	4	19	5	23	17.4	82 6	21.7
	68	1	16	1	17	5.9	94.1	5.9
	69	7	20	6	27	25.9	74.1	22.2
Barnyard manure	82	2	23	12	25	8.0	92 0	48.0
	83	3	16	9	19	15.8	84.2	47.4
	84	3	20	10	23	13 0	87.0	43.5
Barnyard manure and sodium carbonate	79	0	25	17	25	0.0	100 0	68.0
	80	0	20	9	20	0.0	100.0	45.0
	81	0	23	18	23	0.0	100.0	78.3
Barnyard manure, common salt and oxalic acid	64	3	11	6	14	21.4	78.6	42 9
	65	0	11	6	11	0.0	100.0	54.5
	66	12	20	8	32	37.5	62.5	25.0
Barnyard manure and oxalic acid	70	4	23	9	27	14.8	85.2	33.3
	71	4	31	11	35	11.4	88.6	31.4
	72	8	32	17	40	20.0	80.0	42 5
Barnyard manure, sodium carbonate and oxalic acid	76	0	31	12	31	0.0	100 0	38.7
	77	5	7	3	12	41.7	58.3	25.0
	78	1	24	18	25	4.0	96 0	72.0

It will be seen that the results for 1894 were so irregular as to be wholly inconclusive for the reason, as above given, that the seed tubers were but slightly scabbed, and that probably many more germs were introduced in some pots than in others, but more particularly owing to the fact that a sufficient amount of common salt and sodium carbonate was not employed to modify the soil to any great extent in one season. Sufficient time had also not elapsed for either favorable or unfavorable treatment to make a decided showing.

The results for 1895, as will be seen, are not so concordant as regards pots in the same group as might be wished, yet perhaps they are as much so as could be expected. They present, however, some striking comparisons, which are more plainly to be seen by grouping the averages in one table. These averages are calculated from the average number of free, scabbed, badly scabbed and total tubers in each group.

Table showing the average percentages of free, scabbed and badly scabbed potato tubers, when grown with the aid of barnyard manure from scabbed seed tubers, for a second season in the same soil, in connection with oxalic acid and sodium compounds as given in the left hand column.

OXALIC ACID AND SODIUM SALTS USED (CHEMICALLY PURE).	Per cent. free from scab.	Per cent. scabbed.	Per cent. badly scabbed.
Sodium chloride, (Na Cl or common salt)........	17.9	82 1	17.9
None..........	11.9	88.1	46 3
Sodium carbonate, (Na_2 CO_3)................ ...	0.0	100 0	64 7
Oxalic acid and sodium chloride, (common salt)..	26.3	73.7	35.1
Oxalic acid....................................	15.7	84.3	36.3
Oxalic acid and sodium carbonate................	8.8	91.2	48.5

By an inspection of the above table it will be seen that where sodium chloride (common salt) was used there is a greater per-

centage of tubers free from the scab, a less number scabbed and a far less number badly scabbed, than where the barnyard manure was employed with nothing else. On the other hand, where the same amount of sodium in the form of the carbonate was employed, every tuber was scabbed, and the badly scabbed ones were increased 20.4 per cent. The results with common salt may have been due to a direct germicidal action, while on the other hand the sodium carbonate evidently favored the development of the disease. Whether this action is attributable to the neutralizing effect of the sodium carbonate upon the acids of the soil, or to the fact that carbonates were thus introduced, remains uncertain, though, owing to the fact that sodium carbonate is readily soluble and the calcium carbonate not, the former would be expected to combine with the soil acids more readily than the latter, whereby the liberation of the carbonic acid and consequent destruction of the carbonate might result. If such was actually the case, this action of sodium carbonate would find its most satisfactory explanation upon the ground that it had decreased the acidity of the soil, and thereby promoted the development of the scab. It will be noticed, also, in the above table of averages, that where oxalic acid was employed greater freedom from the scab and less badly scabbed tubers resulted than where barnyard manure was employed without it. Where it was used in connection with common salt it will be seen that less scab resulted than where the salt was used alone, though the results on badly scabbed tubers, in the same connection, are directly contradictory. In connection with sodium carbonate, however, it will be seen that it lessened both the scabbed and badly scabbed tubers. It is seen, therefore, that, with one exception, there is an apparent decided advantage from the use of the oxalic acid, and it seems probable that this would be magnified by applying it during the period of the development of the tubers, as previously suggested. Owing to the fact that oxalic acid is not truly representative of the natural acids of the soil the deductions from the one may not apply to the other, yet the results lend more probability, in connection with those obtained with various forms of lime and with sodium carbonate, to the idea that the soil, when in an acid state, furnishes a great degree of immunity from the potato scab. It should also be stated that the oxalic acid, especially in 1894, seemed for a time to exert a favorable influence at least upon the growth of the potato tops.

UPON THE AMOUNT OF SCAB PRODUCED IN CASE OF SUCCESSIVE CROPS OF POTATOES UPON SOIL FAVORABLE AND UNFAVORABLE TO THE DEVELOPMENT OF THE DISEASE.

The results which we are about to record were secured upon the permanent experiment plots Nos. 27 and 29. Owing to the fact that beets are also subject to the scab, provided the germs of the disease are present in the soil, sugar beets were planted between the potato hills, merely to indicate whether the soil was already contaminated or not. From a careful examination of the beets it was found that nearly all of those grown in each of the four rows on the limed plots were scabbed, so that the soil was evidently already contaminated before the 1895 seed tubers were planted. It might be claimed that the germs from the potato hills which had been introduced on the seed tubers might have reached the beets, and while such a thing is possible it does not seem probable, owing to the fact that beets which were grown in 1894 in a similar manner, upon soil supposed to be uncontaminated, were wholly unaffected by the scab, even though the potato tubers in the alternate hills were scabbed. Upon the unlimed plot the beets which were grown in 1895 under similar circumstances were absolutely free from the scab. It seemed probable, therefore, that the soil of each row on the limed plot had remained in a contaminated state due to germs introduced by previous crops. On the other hand, however, the beets gave evidence that the germs of the disease which had been introduced in each case by tubers from the same lot, had on the unlimed plot been rendered by the lapse of time incapable of further injury.

The results secured with potatoes are embodied in the following table:

Table showing the amount of scab on limed and unlimed plots, where a like degree of contamination from seed tubers had previously resulted.

(The limed and unlimed soil was manured alike with sodium nitrate, muriate of potash and dissolved boneblack. Where air-slacked lime was used, it was at the rate of 2½ tons per acre in 1893 and ½ ton per acre in 1894, but remained without further application in 1895.)

		Per cent. free from scab.	Per cent. scabbed.	Per cent. badly scabbed.
Limed, Tubers treated*	On line of row grown from treated "seed" in 1894.	48.0	52.0	24.0
Unlimed, " "		100.0	0.0	0.0
Limed, Tubers untreated		0.0	100.0	75.0
Unlimed, " "		96.3	3.7	0.0
Limed, Tubers treated*	Near line of row grown from untreated "seed" in 1894.	9.5	90.5	85.7
Unlimed, " "		100.0	0.0	0.0
Limed, Tubers untreated		0.0	100.0	84.2
Unlimed, " "		96.3	7.1	0.0
Limed, Tubers treated*	On line of row grown in 1893 and 1894 from untreated "seed."	0.0	100.0	100 0
Unlimed, " "		100 0	0.0	0.0
Limed, Tubers untreated		0.0	100.0	100.0
Unlimed, " "		100.0	0.0	0.0
Limed, Tubers treated*	On line of row grown in 1894 from untreated "seed."	29.2	70.8	29.2
Unlimed, " "		93.1	6.9	0.0
Limed, Tubers untreated		10.3	89.7	72.4
Unlimed, " "		90.0	10.0	0.0

* With corrosive sublimate solution.

Diagram showing percentage of scabbed tubers grown from treated and untreated seed tubers on limed plot No. 29, and the relative position of the rows in 1895.*

NOTE. The above results were obtained by planting treated tubers on half of the length of each row and untreated ones on the other half. In 1895 beets were grown between the hills in all of the potato rows, but they were in all cases scabbed. A careful examination failed to reveal any trace of scab on the beets grown on row number 5, or on those from the three rows next following, showing that even though contamination had resulted on row number 4, in 1894, it had not spread to a distance of seventeen feet in 1895. This fact lends further probability to the conclusion that in 1894 the soil on row number 1 was as yet uncontaminated from the old row (row number 3) of 1893, which was sixteen feet distant. The per cent. of scab on rows numbers 1, 2 and 3, where treated seed tubers were used, gives an idea of the relative degree of contamination of the soil as a result of previous crops. A comparison of these results with those on the same rows where untreated seed was used, shows the advantage from the corrosive sublimate treatment upon soil except (as was the case on row number 3) where a high degree of contamination has already resulted.

* No. 1, treated row in 1894; No. 2, new row in 1895; No. 3, untreated row in 1893 and in 1894; No. 4, untreated row in 1894; No. 5, the first of a group of four rows of beets in 1895.

From the presence of the scab upon the beets above-mentioned it appears that the soil of the limed plot, where each of the four rows of potatoes was grown in 1895, was probably already contaminated. Upon the unlimed plot the conditions for contamination, so far as concerns the condition of the seed tubers, the location of the rows, operations of tillage, etc., were as nearly identical as possible, so that, had the soil not acted as a disinfectant, there would have been every reason to expect a scabby product upon this plot also. It will be seen that with one exception, where the tubers were first treated with corrosive sublimate and planted upon unlimed soil, no scab resulted, showing that upon this soil, when unlimed, the germs introduced upon the seed tubers of previous years had been destroyed or rendered inactive. The fact also that the sugar beets grown between the potato hills upon the unlimed plot were free from scab, further supports this conclusion.

On the unlimed plot, where untreated seed tubers were used, it will be seen that the untreated "seed" produced, in every instance but one, a small amount of scab. From this, and the fact that the beets were free from the disease, it seems probable that the scab noticeable on the unlimed plot was due to the germs of the disease which were introduced upon the seed tubers of 1895, rather than to any from previous years which might have survived the soil conditions. In one instance it remains doubtful whether the scab resulted from germs which might have remained in an active state from the previous season, or from a few germs which escaped destruction by the corrosive sublimate treatment in 1895. The latter seems more probable, however, in view of the fact that in three instances no scab resulted where the treated seed was employed, and, furthermore, when we remember that the results by several experimenters heretofore cited, as well as previous results of our own, all indicate that some germs may escape destruction by the treatment.

The results on the limed plot, in all cases where a moderate amount of contamination existed previously, have shown a decided advantage from the use of the corrosive sublimate treatment. However, where two successive crops had been grown previously from untreated seed tubers, and the opportunity for contamination had been most favorable, it will be seen that notwithstanding the treatment of the seed tubers the third year, 100 per cent., or, in other words, every tuber was so badly scabbed as to be wholly

unfit for market purposes. These results show in the most striking manner the danger that may arise by treating soils intended for potato crops, either successively or in frequent rotation, with substances which will make the soil highly favorable to the potato scab, and also that upon soils which are already in a condition favorable to the development of the disease, the corrosive sublimate treatment, or other means of lessening the contamination by the seed tubers, should never be omitted.

It must also be obvious, as pointed out in our earlier publications, provided the corrosive sublimate or other treatment fails to destroy all the germs upon the seed tubers, and the soil conditions are highly favorable to the propagation of the disease, that the introduction of a few germs and their consequent multiplication must prove disastrous, if potatoes are grown successively or in frequent rotation. Whether or not potatoes can be grown with safety under such conditions at *intervals of several years*, provided no other root crops are introduced in the rotation, can only be determined by actual experiment. It is known that the fungus which causes the disease will grow in various media, and not exclusively upon potatoes and other root crops, yet it may be possible that the soil of itself, no matter how favorable it may be, may not be able to propagate it indefinitely, or for any considerable number of years, without the intervention of an occasional root crop. If this should prove to be the fact, then the increased percentage of merchantable tubers due to liming would be attainable without material injury from scab, provided the crops followed one another at sufficiently great intervals.

UPON THE EFFECT OF LIME IN VARIOUS FORMS UPON THE DEVELOPMENT OF THE POTATO SCAB.

The pots and soil employed in this experiment were exactly like those used in connection with that described on page 62, and were filled at the same time. In order to test the effect of various forms of lime upon the development of the potato scab, it was necessary to avoid the use of barnyard manure, owing to its alkaline reaction and the presence and formation of carbonates within it, and since, owing to the naturally exhausted condition of the soil, it was out of the question to attempt to secure any considerable development of tubers without resort to artificial means, it was decided to employ a mixture of materials which would have an

action like that of ordinary commercial fertilizers. The following shows the amounts and kinds of fertilizing materials used in each pot in both 1894 and 1895:

	1894. grams.	1895. grams.
Dried blood	21	20
Sodium nitrate	5	7
Muriate of potash	10	10
Dissolved boneblack	25	25

The fertilizer was thoroughly mixed with the soil, after the lime had first been well incorporated with it. Lime was employed in 1894 and 1895 as indicated in the following table. One group of pots remained, both years, unlimed. The results secured in 1894, though far less conclusive[1] than those obtained this season, are, as may be seen by comparing them with the following table, essentially the same. *Untreated seed tubers which were all slightly scabbed were used in 1894, and those employed in 1895 were practically covered with the scab. (See Fig. 2.)*

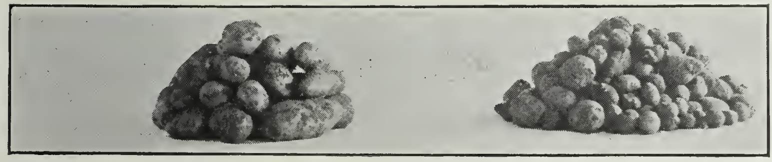


FIG. 1.

Seed-tubers used in Experiment, pages 62 to 67.

FIG. 2.

Seed-tubers used in Experiment, pages 72 to 76.

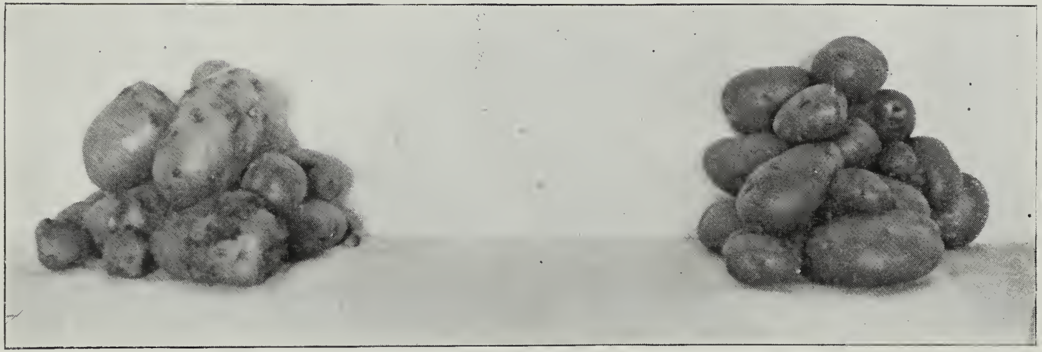
[1] Bull. 30, R. I. Agrl. Expt. Station, Nov., 1894, pp. 79-82.

Table showing the effect of various compounds of lime upon the development of the potato scab. (See Figs. 3, 4, 5 and 6.)

(Each pot received the same amount of fertilizer, composed of dissolved boneblack, muriate of potash, nitrate of soda, and dried blood. Lime where used was employed in 1894 at the rate of 2½ tons of air-slacked lime per acre, and in 1895 at the rate of ½ ton per acre. The pots receiving calcium compounds were given quantities containing the same amount of calcium, irrespective of its form.)

FORMS OF LIME EMPLOYED.	No. of pot.	No. of tubers free from scab.	No. of tubers scabbed.	No. of tubers badly scabbed.	Total No. of tubers.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Air-slacked lime	29	1	19	16	20	5.0	95.0	80.0
	30	0	22	19	22	0.0	100.0	86.4
	31	0	20	18	20	0.0	100.0	90.0
Unlimed	34	26	4	0	30	86.7	13.3	0.0
	35	16	8	3	24	66.7	33.3	12.5
	36	10	4	1	14	71.4	28.6	7.1
Calcium chloride*	39	5	0	0	5	100.0	0.0	0.0
	40	5	0	0	5	100 0	0.0	0.0
	41	6	0	0	6	100.0	0.0	0.0
Calcium sulphate* (Plaster or gypsum)	44	5	13	7	18	27 8	72 2	38.9
	45	10	7	0	17	58.8	41.2	0.0
	46	18	2	0	20	90.0	10.0	0 0
Calcium carbonate*	49	1	35	30	36	2.8	97.2	83.3
	50	0	31	30	31	0.0	100.0	96.8
	51	0	34	29	34	0.0	100.0	85.3
Calcium oxalate*	61	0	19	19	19	0.0	100.0	100.0
	62	0	26	24	26	0.0	100.0	92.3
	63	2	24	22	26	7.7	92.3	84.6
Calcium acetate*	74	3	43	43	46	6 5	93.5	93 5
	75	0	36	36	36	0.0	100 0	100.0
Wood ashes	28	0	22	19	22	0.0	100 0	86.4
	73	0	30	28	30	0.0	100.0	93.3

* Chemically pure.



Air-slacked lime. Fig. 3. Unlimed.

Calcium sulphate (Plaster or Gypsum). Fig. 4. Calcium chloride.

Calcium carbonate. Fig. 5. Calcium oxalate.

Calcium acetate. Fig. 6. Wood ashes.

In order to facilitate comparisons, the averages calculated from the foregoing table have been grouped as given below. These averages were calculated from the average number of free, scabbed, badly scabbed and total tubers in each of the above groups.

Table showing the average percentages of free, scabbed, and badly scabbed potato tubers when grown from scabbed seed tubers for two successive years in the same soil, in connection with various forms of lime.

(Calculated from the foregoing table.)

Forms of Lime Used.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Air-slacked lime	1.6	98.4	85.5
No lime	76.5	23 5	5.9
Calcium chloride ($Ca\ Cl_2$)	100.0	0.0	0.0
Calcium sulphate* (Plaster or gypsum)	60.0	40.0	12.7
Calcium carbonate ($Ca\ CO_3$)	1.0	99.0	88.1
Calcium oxalate	2 8	97 2	91.5
Calcium acetate	3.7	96.3	96.3
Wood ashes	0.0	100.0	90.3

With the exception of pot 44 in the calcium sulphate group, in the first of the two preceding tables, it will be seen that the results are as uniform as could well be expected. They also agree fairly well with those where no lime was employed. Calcium chloride proved to be, as is claimed, poisonous in its effects, and this was true not only upon the potato itself but also upon the scab fungus, for the tubers produced were few and small, and were absolutely free from the scab. The air-slacked lime probably contained some lime in the caustic state, though most of it had doubtless passed already into the form of carbonate. That in the wood ashes was also probably in the same form. Owing to the rapidity with which such substances decompose under favorable conditions, it is probable that the acetate and oxalate of calcium were also changed

* These figures are based upon the average of the results from the three pots. In view, however, of the exceptional result from pot 44, the percentages have also been calculated, based upon the results secured in the other two pots. Calculating the average percentages in this way, we have the following: per cent. free from the scab, 75.7; per cent. scabbed, 24.3; per cent. badly scabbed, 0.0 These results are very close to those secured without lime. While it is evident that a large variation even in the results in these two pots exists, by a comparison with the results where other forms of lime, excepting the chloride, were used, it is overwhelmingly convincing that if the calcium sulphate favored the development of the scab as caused by the fungus, this action must be infinitesimal compared with that exerted by lime in the form of the carbonate, or in forms which change into carbonate in the soil.

into carbonate in the soil, so that eventually their action would be identical with that exerted by the air-slacked lime, calcium carbonate and wood ashes. As will be seen, the results are as uniform as could be expected, and the action of all those forms of lime is highly conducive to the development of the potato scab. It is shown conclusively, therefore, that the influence of lime upon the development of the potato scab depends entirely upon the particular combination in which it exists in the soil. It appears, also, that the prevailing opinion of farmers that wood ashes increase potato scab, and that land plaster, also known as gypsum (calcium sulphate), does not, is probably well founded. Unfortunately, however, as is shown by other experiments at this Station, land plaster, while it is of some benefit in certain connections, cannot perform the same valuable office as air-slacked lime, either in connection with nitrification or in the renovation of our acid soils.

ON THE EFFECT OF BARNYARD MANURE UPON THE DEVELOPMENT OF THE POTATO SCAB.

Before proceeding to a general summary of our experiments, it is of interest to note the comparative effect from the use of barnyard manure and a fertilizer, representative of most of our commercial fertilizers, upon the development of the potato scab.

The soil employed was uniform in all respects, and the degree of scabbiness of the seed tubers in each group was in 1894 as well as in 1895 as nearly identical as possible. These results are from the pot experiments heretofore described.

	Per cent. tubers free from scab.	Per cent. scabbed.	Per cent. badly scabbed.
Fertilizer (artificial)........	76.5	23.5	5.9
Barnyard manure........	11 9	88.1	17.9

From the foregoing it appears that much more scab resulted from the use of barnyard manure than from the fertilizer, and it might be argued that this was due to the additional germs introduced in the manure itself.

In view of the thorough infection due to the use of scabbed seed tubers for two successive years, and particularly in consideration of the fact that those used in 1895 were practically covered

by the scab, it would not seem reasonable to attribute such vast difference in the scabbiness of the product to the introduction of a few more germs by means of the barnyard manure, even had their presence in it been certain. It is possible, on the other hand, that the fertilizer may have exerted some slight germicidal action, but, again, it would appear to be unreasonable to attribute more than a very small portion of the difference to this factor. The most reasonable explanation, therefore, for the greater portion of this difference, seems to be that the barnyard manure, owing to its alkaline reaction or to the carbonates in and derived from it, had rendered the soil conditions more favorable for the development of the disease, even aside from any germs of the disease which it may itself have contained.

GENERAL SUMMARY IN RELATION TO THE POTATO SCAB.

1. Experiments for three years show that the growth of the potato scab fungus is promoted by the presence of air-slacked lime.

2. Wood ashes (which like air-slacked lime consist largely of calcium carbonate), pure calcium carbonate, calcium acetate and calcium oxalate, also promote the scab in a high degree.

3. Calcium chloride injured the potato plants but entirely prevented the scab, although an abundance of germs was probably introduced.

4. Calcium sulphate (known as land plaster and gypsum) is the only form of lime employed which has not injured the growth of the crops, and which has at the same time failed to promote with certainty the development of the scab.

5. The form of the lime determines its ability to promote or hinder the development of the disease.

6. Upon our acid soil, which has been partially neutralized by air-slacked lime, the use of ammonium sulphate has, under otherwise like circumstances, resulted in producing tubers less scabby than where the same amount of nitrogen in form of sodium nitrate was used.

7. Common salt (sodium chloride) has reduced the percentage of scab, and since sea-weed carries much salt a satisfactory expla-

nation is afforded for the opinion commonly held that by its use less scab results than without it.

8. Sodium carbonate acts in the same way as calcium carbonate, though perhaps not in the same degree, and promotes decidedly the development of the disease.

9. Barnyard manure, owing to its alkalinity or the production of carbonates from it, has probably in and of itself increased the scab.

10. Oxalic acid seems to have had a tendency, even when applied at the time of planting, to reduce the percentage of scab, though owing to the fact that much of it had probably decomposed before the tubers were formed, very marked results were not obtained.

11. Our experiments for three years on our acid soil, go to show that calcium and sodium carbonates, either by virtue of the combined carbonic acid which they carry, or owing to their action in overcoming the acidity of the soil (by which, perhaps, naturally antiseptic compounds are transformed), do favor, in a high degree, the development of the potato scab.

12. It is obvious that anything which would be employed, in an economical way, to reduce the acidity of the soil, must be a carbonate of some base, or a compound which when introduced into the soil would readily be converted into such.

13. By the use of air-slacked lime, wood ashes, barnyard manure, soda ash (sodium carbonate), or double carbonates of potash and magnesia, the production of scab would be favored.

14. If favorable for its development, the fungus seems to multiply in the soil independent of the continual presence of potatoes or other root crops, though how long this is possible without the occasional intervention of some root crop is unknown.

15. The results show the danger liable to follow even if a few germs are introduced into the soil, provided it is of itself or has been made by injudicious fertilization highly favorable to the development of the scab.

16. It is shown in a striking manner that the corrosive sublimate, or some other satisfactory treatment of the seed tubers, should always be resorted to on soils which are favorable to the development of the potato scab.

17. Upon our acid soil practical immunity from scab has been secured upon three successive crops by the use of fertilizers representing our ordinary commercial fertilizers, even when slightly scabbed untreated seed tubers have been employed.

18. Upon such soil the total yield has been but little increased by liming, though the percentage of large tubers shows an average gain of about 10 per cent.

19. By the use of chemicals our acid soil, which furnishes practical immunity from the scab, is nevertheless capable, at ordinary prices, of producing potatoes at a profit.

20. The claim that the character of a soil has no effect upon the disease "for better or worse" appears to have been entirely unfounded.

21. By the use of ammonium sulphate, and probably muriate and sulphate of potash, kainit and common salt in connection with *dissolved* phosphate rock, dissolved bone, or dissolved boneblack, soils which now tend to produce scabby tubers would probably become less favorable to the disease. It is possible that a rational system of rotation of crops *which would include no beets or other root crops*, and perhaps no cabbages, would also help to alleviate the condition on such soils.

A discussion of the possibility of deriving the desired benefit from liming, and of controlling the scab by preliminary treatment of the seed tubers, and by a suitable rotation of crops, has been already discussed elsewhere. (See pages 46 to 50.)

Bulletin 34. December, 1895

KINGSTON, RHODE ISLAND.

ANALYSES OF FERTILIZERS.

HOME-MIXED FERTILIZERS.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

PRESS OF E. L. FREEMAN & SON, PRINTERS TO THE STATE.

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*Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 34.

ANALYSES OF COMMERCIAL FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL AND C. L. SARGENT.

The fertilizer analyses included in Bulletins No. 32 and 33, together with those given in this Bulletin, embrace those of all the samples which were drawn in connection with the state inspection during the year 1895. The volume of the work has been much greater than in any previous year, owing to the increased number of brands offered for sale.

The following shows the percentage relation between the fertilizing constituents found and guaranteed, for the years 1891 to 1895 inclusive:

	1891. Per cent.	1892. Per cent.	1893. Per cent.	1894. Per cent.	1895. Per cent.
Equal to or above the guaranty..	71.06	80.71	75.74	80.89	88.97
Less than .3 per cent. below the guaranty.	10.64	9.00	13.77	7.97	4.99
More " " " " " " .	18.30	10.29	10.49	11.14	6.04

In 1891 which was the first season in which the fertilizer inspection was conducted in coöperation with the Experiment Station, the goods in 29 per cent. of the cases were below the guarantees, and in 18 per cent. of them over .3 of a per cent. below. In 1892 there was a marked improvement. In 1893 the results were much better than in 1891 but were not equal to those of 1892. In 1894 a decided improvement was again noticeable, and it will be seen that the showing for 1895 is the best yet recorded.

Nothing is better calculated to establish confidence in the minds of consumers of commercial fertilizers than to find that the goods are mixed uniformly from year to year, and that they contain what is guaranteed.

Sample No.	NAME OF BRAND.	MANUFACTURER.	DEALER.
541	Highly Concentrated Horticultural Manure.....	H. & E. Albert, Biebrich, Germany	Wm. Rosenthal, Providence.
507	Bradley's Complete Manure for Top Dressing...	Bradley Fert. Co., State St., Boston, Mass	H. W. Parkis & Co., Slatersville.
508	" Strawberry Manure................	" " " " " " "	Halliday Bros., E. Providence.
436	C. C. F. Co.'s Odorless Chemical Compound Fertilizer for Lawn and Grass...............	Chemical Compound Fert. Co., Dighton, Mass...........................	Geo. A. Weaver Co., Newport.
535	Great Eastern Soluble Bone and Potash..	Great Eastern Fert. Co., Rutland, Vt.....	D. C. Curtis, Apponaug.
486	Mitchell's Standard Superphosphate...........	Mitchell Fert. Co., Tremley, N. J.......	L. S. Bosworth & Son, Barrington.
487	" Vegetable Special for Market Gardeners	" " " " "	L. S. Bosworth & Son, Barrington.
529	National Fert. Co.'s Chittenden Grass Fertilizer.	National Fert. Co., Bridgeport, Conn.....	Richmond & Rogers, Hope Valley.
469	Shoemaker's Superphosphate for General Use...	M. L. Shoemaker & Co., Philadelphia, Pa.	Wardwell Lumber Co., Bristol.
470	" " " Potatoes.......	" " " "	" " " "

Sample No.	Name of Brand.	Water.	Nitrogen: Nitrogen in nitrates.	Nitrogen: Nitrogen in ammonia salts.[1]	Nitrogen: Nitrogen in organic matter.	Nitrogen: Total nitrogen found.	Nitrogen: Nitrogen guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total found.	Phosphoric Acid: Total guaranteed.	Phosphoric Acid: Available: Found.	Phosphoric Acid: Available: Guaranteed.	Potash: Found.	Potash: Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
541	Albert's Highly Concentrated Horticultural Manure..............	3.97	7.49	4.25	....	**11.74**	*12.*	12.05	1.76	.56	**14.37**	....	**13.81**	*13.*	**19.39**	*21.*	1.64	*$74.85*
507	Bradley's Complete Manure for Top Dressing.....	8.10	4.65	..	....	**4.65**	*4.95*	1.38	4.50	1.60	**7.48**	6.	**5.88**	*5*	**3.41**	*2.5*	.88	*24.60*
508	Bradley's Strawberry Manure....	11.39	....	....	2.72	**2.72**	*2.50*	2.97	2.75	2.57	**8.29**	*8.*	**5.72**	*6.*	**5.64**	*5.*	*	*21.67*
436	C. C. F. Co's Odorless Chem. Compound Fert. for Lawn & Grass	2.46	3.85	....	...	**3.85**	*4.70*	.15	1.22	12.31	**13.68**	....	**1.37**	....	**1.00**	*.75*	*	*18.90*
535	Great Eastern Soluble Bone and Potash.....................	15.44	....	....	...	.....	.....	6.31	3.92	.96	**11.19**	....	**10.23**	*10.*	**2.43**	[3]*4.*	*	*14.46*
486	Mitchell's Standard Superphosphate.......	13.34	.59	...	1.85	**2.44**	*2.00*	8.51	2.69	1.11	**12.31**	*10.*	**11.20**	*8.*	**2.38**	*2.*	.15	*23.96*
487	Mitchell's Vegetable Special for Market Gardeners..	10.07	.96	....	2.30	**3.26**	*3.00*	6.72	2.50	1.33	**10.55**	*9*	**9.22**	*8.*	**4.82**	*6.*	50	*26.78*
529	National Fert. Co.'s Chittenden Grass Fertilizer........... ..	10.96	....	1.33	2.20	**3.53**	*4.12*	3.89	5.30	1.60	**10.79**	*8.*	**9.19**	*6.*	**5.60**	*5.*	*	*28.36*
469	Shoemaker's Superphosphate for General Use..................	10.19	.72	.33	1.57	**2.62**	*2.47*	6.19	2.63	5.80	**14.62**	*14.*	**8.82**	*9.*	**4.50**	*4.*	*	*25.25*
470	Shoemaker's Superphosphate for Potatoes................	7.71	.82	....	1.84	**2.66**	*2.47*	2.78	5.02	6.49	**14.29**	*11.*	**7.80**	*8*	**6.39**	*6.*	*	*25.75*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in BULLETIN 32, page 28.

[3] This guaranty is said by the fertilizer company to have been published in their circulars as 2. per cent. instead of 4. per cent., and they claim it to have been a mistake on the part of those intrusted with printing the bags, and that it was not intentional.

Table showing the number of brands of complete fertilizers analyzed during the present season, the manufacturers of the same, and the relation of the guaranties to the amounts of nitrogen, phosphoric acid and potash found.*

MANUFACTURER.	Nitrogen.			Total Phosphoric Acid.			Available Phos. Acid.			Potash.			Summary.				
	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of brands analyzed.	Total No. of guaranties.	Total No. equal to or above guaranty.	Total No. less than .3 per cent. below guaranty.	Total No. .3 per cent. or more below guaranty.
H. & E. Albert, Biebrich, Germany	1	0	0	1	1	0	0	0	0	1	0	1	1	3	1	1	1
H. J. Baker & Bro., 93, 95, 97 William street, New York	3	3	0	0	0	0	3	3	0	3	3	0	3	9	9	0	0
Bowker Fertilizer Co., 43 Chatham street, Boston	13	13	0	12	12	0	12	11	1	13	13	0	13	50	49	0	1
Bradley Fertilizer Co., State street, Boston	8	7	1	8	8	0	8	6	1	8	8	0	8	32	29	1	2
W. J. Brightman & Co., Tiverton, R. I	3	2	0	3	3	0	3	3	0	3	3	0	3	12	11	1	0
Chemical Compound Fertilizer Co., Dighton, Mass	4	2	2	0	0	0	0	0	0	4	4	0	4	8	6	0	2
Daniel T. Church, Tiverton, R. I	3	1	0	3	3	0	3	2	1	3	2	1	3	12	8	2	2
Clark's Cove Fertilizer Co., State street, Boston	6	6	0	6	6	0	6	6	0	6	6	0	6	24	24	0	0
E. Frank Coe Co., 16 Burling Slip, New York	4	4	0	4	4	0	4	3	0	4	3	0	4	16	14	2	0
Crocker Fertilizer and Chemical Co , Buffalo, N. Y	4	4	0	4	4	0	4	2	1	4	4	0	4	16	14	1	1
Cumberland Bone-Phosphate Co., Portland, Me	3	3	0	3	2	1	3	2	1	3	3	0	3	12	10	0	2
L. B. Darling Fertilizer Co., Pawtucket, R. I	5	3	1	5	4	0	3	2	1	5	4	1	5	18	13	2	3
Great Eastern Fertilizer Co., Rutland, Vt	4	3	0	3	3	0	4	2	1	4	4	0	4	15	12	2	1
Mapes Formula and Peruvian Guano Co., New York	4	4	0	4	4	0	4	3	1	4	4	0	4	16	15	0	1
Mitchell Fertilizer Co., Tremley, N. J	4	4	0	4	3	1	4	3	1	4	2	1	4	16	12	1	3
National Fertilizer Co., Bridgeport, Conn	4	2	1	4	4	0	3	3	0	4	3	0	4	15	12	2	1
Pacific Guano Co., Box 1638, Boston	3	3	0	3	3	0	3	3	0	3	3	0	3	12	12	0	0
Parmenter & Polsey, Peabody, Mass	3	3	0	3	3	0	3	3	0	3	3	0	3	12	12	0	0
The Quinnipiac Co., 92 State street, Boston	5	5	0	5	5	0	5	4	1	5	5	0	5	20	19	0	1
Read Fertilizer Co., New York	4	3	0	3	2	1	4	4	0	4	4	0	4	15	13	1	1
M. L. Shoemaker & Co , Philadelphia, Pa	2	2	0	2	2	0	2	0	0	2	2	0	2	8	6	2	0
Standard Fertilizer Co., State street, Boston	3	3	0	3	3	0	3	3	0	3	3	0	3	12	12	0	0
Leander Wilcox, Mystic, Conn	4	4	0	4	4	0	4	4	0	4	4	0	4	16	16	0	0
Williams and Clark Fertilizer Co., 92 State street, Boston	3	2	1	3	3	0	3	2	0	3	3	0	3	12	10	1	1
Total	100	86	6	90	86	3	91	74	10	100	93	4	100	381	339	19	23

* This does not include No. 537 in BULLETIN 33, Peters' Sheep Fertilizer, which was unaccompanied by any guaranty and is consequently omitted from this table.

Table showing the number of complete fertilizers analyzed and the percentage of cases in five years (1891 to 1895 inclusive) in which the brands were, in any of their constituents, equal to or above, less than .3 of a per cent. below, or more than .3 of a per cent. below their guaranties.

MANUFACTURER.	No. of years in which samples were collected.	No. of samples analyzed.*	No. of guaranties.	Percentage of determinations equal to or above the guaranties.	Percentage of determinations less than .3 per cent. below the guaranties.	Percentage of determinations .3 per cent. or more below the guaranties.
1. Parmenter & Polsey, Peabody, Mass	1	3	12	100 00	.00	.00
2. Lucien Sanderson, New Haven, Conn......	1	2	7	100.00	00	.00
3. Mapes Formula and Peruvian Guano Co., New York, N. Y.	4	12	48	97.92	.00	2.08
4. Ames Fertilizer Co., Peabody, Mass........	4	6	24	91.67	8.33	.00
5. National Fertilizer Co., Bridgeport, Conn..	5	18	70	88.58	5.71	5.71
6. H. J. Baker & Bro., New York, N. Y....	4	11	35	88.57	8.57	2.86
7. Quinnipiac Co., Boston, Mass.............	5	26	102	88.24	7.84	3.92
8. Bowker Fertilizer Co., Boston, Mass.......	5	57	225	87.55	5.78	6.67
9. Clark's Cove Fertilizer Co., Boston, Mass..	4	16	64	87 50	9.38	3.12
10. Great Eastern Fertilizer Co., Rutland, Vt.	3	10	39	87.18	7.69	5.13
11. Bradley Fertilizer Co., Boston, Mass.......	5	40	159	85.53	8.18	6.29
12. Pacific Guano Fertilizer Co., Boston, Mass	5	11	43	83.72	11.63	4 65
13. Standard Fertilizer Co., Boston, Mass......	5	12	48	83.34	8.33	8.33
14. Leander Wilcox, Mystic. Conn............	4	15	60	83.33	5.00	11.67
15. Williams & Clark Fert. Co., Boston, Mass..	5	18	72	80 55	12.50	6.95
16. Read Fertilizer Co., New York, N. Y......	5	20	75	78.68	10.66	10.66
17. Cumberland Bone-Phosphate Co., Portland, Me....	4	7	28	78.58	10.71	10.71
18. W. J. Brightman & Co., Tiverton, R. I....	5	13	44	77.27	4.55	18.18
19. M. L. Shoemaker & Co., Philadelphia, Pa.	1	2	8	75.00	25.00	.00
20. Chemical Compound Fertilizer Co., Dighton, Mass..................................	1	4	8	75.00	.00	25.00
21. L. B. Darling Fertilizer Co., Pawtucket, R. I	5	18	59	71.19	10.17	18 64
22. Mitchell Fertilizer Co., Tremley, N. J.....	5	20	74	68.92	9.46	21 62
23. John S. Reese & Co., Baltimore, Md.......	1	3	12	66.67	25.00	8.33
24. Crocker Fert. & Chemical Co , Buffalo, N. Y.	4	17	68	64.70	17.65	17.65
25. Daniel T. Church, Tiverton, R. I..........	5	13	45	64.44	15.56	20.00
26. E. Frank Coe Co., 16 Burling Slip, New York, N. Y....	5	22	81	62 96	11.11	25.93
27. Lister's Agricultural Chemical Works, Newark, N. J.......	1	2	5	60.00	20.00	20.00
28. F. C. Sturtevant, Hartford, Conn.	1	1	2	50.00	50.00	.00
29. H. & E. Albert, Biebrich, Germany........	1	1	3	33.34	33.33	33.33
30. C. Meyer, Jr., Maspeth, Long Island.......	1	2	6	33.33	16.67	50.00
31. Davidge Fertilizer Co., New York, N. Y...	2	3	12	25.00	16.67	58.33
32. Earle Phosphate Co., Providence, R. I.....	1	1	4	25.00	.00	75.00
33. Le Page Company, Boston, Mass....	1	1	4	25.00	.00	75.00
Summary..	..	407	1546	80.34	8 92	10 74

* A few fertilizers were unaccompanied by guaranties and have, consequently, been omitted.

HOME-MIXED FERTILIZERS.

H. J. WHEELER AND B. L. HARTWELL.

For several years a number of our agricultural experiment stations have advocated strongly the home-mixing of fertilizers. As a consequence a few of the more progressive farmers in several states have given the matter a thorough test. Owing to the recent establishment of the Experiment Station in this State, the number of Rhode Island farmers who have as yet given the matter attention is small. It has been deemed wise, however, at this time to collect some of the results of their experiences, and also a number of fertilizer formulas, and publish the same in a systematic manner, so as to make the data more accessible. Recognizing at the outstart that farmers are more ready to accept the statements of other farmers, who have had practical experience in such matters, than those coming from any other sources, we will give some abstracts from statements which have been kindly furnished for the purpose by parties who were known by us to have experimented for themselves.

OPINIONS IN RELATION TO THE ADVANTAGES OF HOME-MIXING.

Byron A. Andrews, of Slatersville, R. I., states that "The mixing of the ingredients is a small matter, as two men can pound lumps, sift and mix enough in half a day to supply fertilizer for five acres, and I believe it is as well mixed as any that we can buy. The conclusion that I have arrived at is that farmers, by purchasing the ingredients in considerable quantities and of guaranteed quality, can save nearly if not quite 40 per cent. and will not run the risk of paying their money for worthless goods."

Francis M. Wood, of Harrisville, reports that the results from mixtures prepared from special formulas have, on Indian corn, potatoes and barley, been "very satisfactory." Further reference will be made to his results later on.

J. S. Madison, of East Greenwich, says "For the past two years I have mixed my own fertilizer and like the plan both for convenience and low price." He further adds: "From my own experience and from what I have seen of that of other people I think the sooner the farmers of Rhode Island buy their own chemicals and do their own mixing the better it will be for them."

S. Sanford, of Portsmouth, R. I., makes the following statement: "On the whole I think it pays to buy materials and mix. I can save at least five dollars per ton by so doing."

G. H. Wood, of Natick, R. I., says: "I can get greater results from home-mixed fertilizer than from anything that I can buy."

George E. Sisson, of South Portsmouth, in speaking of the formulas used by the Portsmouth Grange, states that they "were used by quite a number of our members and almost all say they were as good or better than other kinds of high grade fertilizers costing more money. One member says he will use twelve tons of No. 2 next season."

Joseph A. Tillinghast, of Summit, says: "I am a firm believer in home-mixed fertilizers because I can buy more plant food for the same money than in mixed goods; also by testing the soil and the growth of the various crops, I can more intelligently and economically furnish the necessary plant food for a profitable crop."

Isaac L. Sherman, of Portsmouth, R. I., in commenting upon the formulas used by the Portsmouth Grange in 1895, states that "they all gave better results than the best grades of commercial fertilizers used beside them, and in some cases the results were very much better." He also adds that Mr. Potter, Master of the Nonquit Grange of Tiverton, states that the same formulas did as well as any fertilizer that he ever used. Mr. Sherman also states that they were used in Jamestown, Middletown, Portsmouth and Tiverton, and he has heard but two or three say that they did not do as well or better than the commercial fertilizers they used. These mixtures were purchased at about ten dollars per ton less than the average cost of other potato manures. The analyses and valuations of these will be given farther on.

Edward B. Williams, of Providence, R. I., reports having mixed a fertilizer which cost him, including $1.50 per ton for mixing, but $28.50, while the estimated cost from a manufacturer was $40. He says: "No lack of efficiency appeared in the crop result," and also that he is "satisfied that the farmer can safely depend upon

honest chemical fertilizers, and that it is much cheaper to buy and mix the materials himself, depending upon leguminous plants for his main supplyof nitrogen, in a judicious rotation of crops."

W. King & Són, of Kenyon, R. I., say: "We used the formula you gave us last spring. We put together one ton of the mixture and used some of it on corn and some on potatoes. We are of the opinion that it was a good fertilizer. The cost was about $25 per ton, and that of mixing, nominal. It did not take long to shovel it over a few times. Where we used it on potatoes the ground was in good condition, but it gave us fully as good returns as the ——— Phosphate did, and that cost $30. On the corn it showed better than the phosphate. At cutting time there was a great difference."

G. R. Hicks, of Bristol Ferry, R. I., reports that he began mixing fertilizers three years ago and that the results were so satisfactory in comparison with ready-mixed goods that he has discarded the latter altogether.

E. G. Macomber reports good results from home-mixed goods, and describes an improvised "mixer" which he uses.

H. A. Brooks, of Slatersville, states that he is of the opinion that he can mix his own fertilizer sufficiently well for all practical purposes and with little expense, for one man can mix two tons in a day.

C. W. Prescott, of Concord, Mass., who has thirteen and a quarter acres of asparagus, writes as follows: "My first experience with chemicals was in 1886, when my crop of asparagus was increased by the enormous quantity of 900 of dozens from the same beds. Naturally my enthusiasm for chemicals has been very great ever since. Stable mauure had been used previous to 1886 in fairly liberal quantities." Mr. Prescott further adds: "Then, again, why should the farmers pay from $9 to $15 per ton more for a fertilizer than it is worth?" He suggests that they should combine in purchasing, each making a deposit in the bank beforehand for his purchase, so that the business may be upon a cash basis. He states that if ten or fifteen large consumers would combine in this way, a saving of $1,000 could easily be made, and that if the farmers of the country would do business upon that basis they might put thousands of dollars in their pockets.

HOW TO BUY CHEMICALS AND OTHER FERTILIZER STOCK.

By all means buy for cash, and if necessary borrow the money. Having made a list of those materials which might come into consideration in making the home-mixture, a copy of the same should be sent to a number of manufacturers or dealers with a request for quotations on ton or car-load lots. Reduced rates may often be obtained even though several different materials are ordered, provided the whole amounts to enough for a car-load. Upon the receipt of the quotations it is a simple matter in most cases to ascertain which prices are most favorable. This is particularly true of muriate of potash, sodium nitrate, ammonium sulphate, and such other materials as are of practically constant composition. The chief difficulty is met with in the purchase of tankage where the material from different manufacturers seldom contains like amounts of nitrogen and phosphoric acid, and where one manufacturer guarantees bone phosphate and another phosphoric acid.

The following will assist materially in reducing such quotations to a common basis:

Multiplying the per cent. of ammonia by .82 gives the nitrogen.
" " " " " nitrogen by 1.21 gives the ammonia.
" " " " " pure* muriate of potash by .63 gives the actual potash.
" " " " " actual potash by 1.58 gives the pure muriate of potash.
" " " " " pure* sulphate of potash by .54 gives the actual potash.
" " " " " actual potash by 1.85 gives the pure sulphate of potash.
" " " " " bone phosphate by .46 gives the phosphoric acid.
" " " " " phosphoric acid by 2.18 gives the bone phosphate.

If 50 per cent of potash is guaranteed that means 50 pounds of actual potash in 100 pounds of the muriate or sulphate of potash, as the case may be. If the price of muriate of potash is $42 per ton, the price for 100 pounds is of course $\frac{1}{20}$ of that, or $2.10, and if 50 pounds of actual potash are contained in 100 pounds of the muriate, then one pound would cost $\frac{1}{50}$ of $2.10, or in other words, 4.25 cents, so it is seen that if muriate of potash is offered to con-

* Ordinary muriate of potash as commonly sold contains but about 80 lbs. of muriate of potash per hundred, the balance consisting chiefly of common salt, while ordinary high grade sulphate contains about 90 lbs. of sulphate of potash per hundred.

tain 50 per cent. of potash and is sold at $42 per ton, then each pound of potash costs just 4¼ cents.

If one is comparing two samples of tankage the per cent. of nitrogen is multiplied by 20 to find how much nitrogen is in a ton, and having found this, one can estimate its value in each, at 16 cents or any other desired price per pound, and after deducting the value of the nitrogen, can then calculate from the balance the cost per pound of the phosphoric acid in each, in exactly the same manner as the cost of the potash in muriate of potash was determined. Or reckoning the value of the phosphoric acid in each at a given price, the relative cost of the nitrogen may be similarly determined. If any points present themselves about which further information or assistance is desired it is a simple matter to write to the Station concerning it. In all cases, when buying bone or tankage, insist upon having the material finely ground. Many farmers think it is desirable to have it coarse enough so it will stay in the soil for a number of years, but it must be evident that the quicker the returns from the investment are obtained, the more profitable it will be. The relative returns from the coarse and fine material may well be likened to those from money at simple and compound interest. The Experiment Station determines and reports upon the relative fineness of such material, so that the purchaser can readily compare the goods of various manufacturers in this respect. Muriate and sulphate of potash, sodium nitrate and ammonium sulphate, are so easily dissolved by the rain water, that their fineness is less important. These materials cake, however, upon standing, and are much more easily mixed if they are freshly ground. Recognizing this, purchasers frequently stipulate that all the materials which are at all caked shall be freshly ground, and then take pains to mix them as soon as possible after their arrival. The larger dealers in these materials are able to grind them at small additional expense. Frequently a sufficient saving can be made by purchasing in the late fall or early winter, to more than compensate for the labor involved in pounding any material which may have caked, provided, however, the materials can be kept in a dry and suitable store-house.

HOW TO MIX FERTILIZERS.

In fertilizer factories where the business is conducted on a large scale, machines are employed which are so constructed as to mix

considerable quantities at a time, and do it rapidly. The conditions existing upon the majority of farms, are such that an elaborate arrangement, even for mixing small quantities at a time, will not be brought into use, and a tight barn floor and square pointed shovel will be the only requisites at disposal. Under such circumstances after weighing out the quantities to be mixed they should be spread upon the floor in layers one upon the other. Then beginning at one side and working across, the whole should be shovelled over; this may be levelled somewhat and the operation repeated until the mixing is satisfactory. In addition to the shovel and the barn floor a large screen such as is used in screening gravel or coal ashes, may be employed with decided advantage; the material at the first mixing can be thrown upon the screen and by this means lumps may be separated and more easily broken up and the thoroughness of the mixing will be increased. It may be desirable to employ the screen as an aid to the mixing even in the subsequent shovelling over, to which the material is subjected. Owing to possible losses of nitrogen and frequently to undesirable changes in the form of the phosphoric acid, it is usually not advisable to mix the material long before using.

THE COST OF MIXING.

The cost of mixing fertilizers is estimated by those who have practiced it in Rhode Island, at from $0.50 to $1.50 per ton, the average estimate being about $1.00. Several farmers state that they generally do their mixing on rainy days when little else could be done so that it costs practically nothing.

CAN THE FARMER MIX IN A SATISFACTORY MANNER.

The first statement that the fertilizer agent will advance for the discouragement of home-mixing will be to the effect that so thorough a mixture cannot be obtained as is possible by the machines employed in fertilizer factories. The facts of the case are about as follows: In the manufacture of superphosphates which should and do enter into the composition of most fertilizers, a small quantity of free sulphuric acid is liable to be present unless proper care is exercised. Such free sulphuric acid (oil of vitriol) is poisonous to plants, and some manufacturers claim that they always mix a small amount of tankage, bone, or undissolved phos-

phate with the fertilizer in order that it may upon standing, fully neutralize the sulphuric acid. Admitting that they do, the farmer can do this also, or if his soil contains calcium carbonate or has been treated generously with wood ashes, air-slacked lime or marl, no danger will arise from such small quantities of sulphuric acid as are actually met with for the lime will neutralize it at once. Again, it must be borne in mind that with the exception of the organic nitrogen and the phosphoric acid in the reverted and insoluble forms, the active ingredients are all easily soluble in water, and whether mixed a little more or less intimately the first rains will inevitably dissolve them and cause an equally satisfactory mixture with the soil. In fact, when considered from an unprejudiced standpoint, it will be seen that this argument against home-mixing can have little if any practical foundation.

Mr. J. S. Madison, of East Greenwich, Rhode Island, desired to ascertain for himself whether this *intimate* mixing of the constituents was so necessary as claimed. He accordingly weighed out enough of each ingredient for a dozen hills of Indian corn and put them in the hills "*without mixing at all.*" He states that they were carefully placed so that they were not in contact, "and the result was all that could be desired." He also writes as follows: "As to the cry of the fertilizer maker that fertilizers cannot be properly mixed without special machinery that will produce a perfect contact mixture, I do not believe that any such great amount of mixing is necessary, all that I ask for is enough mixing to insure a proper proportion in each hill."

HOW SHALL THE SPECIAL NEEDS OF SOILS BE DETERMINED?

At present no fully satisfactory chemical method is known for the determination of the needs *in all particulars* of soils which have been long under cultivation. The agricultural chemists of this country and Europe are, however, making progress along this line, and it does not appear improbable that much may yet be accomplished. The upland soils in many portions of Rhode Island have been found to be too acid or sour for the most profitable production of many crops, a condition which has been corrected, with the most happy results, by the use of air-slacked lime, in Hope Valley, Westerly, West Kingston, Usquepaugh, and on the farm of the Experiment Station at Kingston. For making this test small strips of blue litmus paper, which can be had for a few cents from any apothecary, are employed.

TESTS FOR ACIDITY.

A few tablespoonfuls of soil are put in a glass or cup, and moistened with sufficient water to make a mixture of the consistency of thick paste, then a piece of blue litmus paper ½ an inch wide and 2½ inches long is introduced into this mass after it has stood for ten or fifteen minutes. After having remained in contact with the moist soil for two or three minutes, it is carefully removed, rinsed with water and allowed to dry. If after drying a red color still persists instead of the original blue there is evidence that the acid condition is not caused by carbonic acid, but rather by organic acids or acid salts, and the necessity for liming is thus made evident. The fingers should never be applied to the end of the litmus paper which is introduced into the soil, for they always impart to it a red coloration, and if care were not taken in this particular the change in color caused by the finger touch might be attributed to the soil itself. This holds true both during the insertion and the removal of the litmus paper. A spoon or a knife blade, or anything of that kind may be used for parting the soil and for tucking the end of the litmus paper down into it, after which the soil may by this means be pressed about the paper. From three years' experiments at this Station it appears that some plants grow as well and some even better upon the acid soil, than they do after liming, while others are practically a failure without lime.

A systematic arrangement of most of the plants thus far tested, showing their peculiarities in this respect, can be found in the Seventh Annual Report of this Station, pp. 158 to 160.

Among the plants most benefited by liming such soils, are: spinach, lettuce, gumbo, beets of all kinds, salsify, celery, onions, parsnips, clover, timothy, Kentucky blue grass, muskmelons, tobacco, cauliflower, cucumber, sorghum, martynia, peppers, peanuts and barley.

Among those benefited by liming, but in a less degree, are: rape, garden peas, kohl rabi, Brussels sprouts, wax beans, buckwheat, ruta bagas, spring wheat, white carrots, kale, sweet corn, oats, dandelion, and apparently certain of the grasses.

Among those plants which have shown little or no benefit from liming, are: millet, Hungarian, soja or soya bean, common white bean, radish, yellow carrot, Indian corn, watermelon, lupine and sorrel (*Rumex acetosella*).

In 1894 a few plants which were either not benefited or else slightly injured by the fresh applications of lime, appear in 1895, during which year no further application of lime was made, to have been benefited by its use. This is particularly true of the yellow carrot, which would indicate that if carrots are to be grown on limed soil they should not be sown the same year the lime is applied, but one or perhaps two or three years later. Sorrel which was injured by the lime the season of its application has grown well upon the limed soil a season later. It will be seen, therefore, if a few of our agricultural plants which are mentioned in the last group are not introduced into the rotation until the first or second year after liming, that the watermelon and lupine are about the only ones experimented with, which may be expected to show an injury from liming on our acid soil.

It must be obvious that it would be absurd for a farmer who wants to learn from tests with and without lime whether his soil is deficient in that constituent to use for that purpose, Indian corn or any other plants enumerated in the last group, for a satisfactory result could be secured only with one of the first mentioned group of plants.

TEST WITH BEETS AND LIME.

One of the most easily weighed and managed and therefore most practical plants for testing for a lack of carbonate of lime in soils is the beet, particularly the mangel wurzel. A practical way of testing would be to lay out two plots about 27 by 27 feet, which should be separated by a path 6 to 8 feet wide. Each plot should then be manured with an equal weight of some good commercial fertilizer, and to one of them from 60 to 70 pounds of air-slacked lime should be applied. In place of the fertilizer it would be preferable to use on each plot 8 pounds of sodium nitrate, 10 pounds of dissolved boneblack, and 5 pounds of muriate of potash. The fertilizer may be sown broadcast and harrowed, cultivated or raked in after the lime has first been applied in a similar manner. The reason for applying the lime first is that it may be most thoroughly mixed with the soil, a point which is absolutely essential to satisfactory results the first season.

PRACTICAL TEST FOR A DEFICIENCY OF POTASH, PHOSPHORIC ACID AND NITROGEN.

In this test seven plots are generally employed, though but three or at most five are usually to be recommended for actual farm practice. The busy farmer has neither patience nor money sufficient to allow him to go to all the trouble that may be taken at an experiment station. In general it is not advisable to undertake an experiment of this kind unless it is to be continued for at least two and possibly three or four years, as the case may demand. If the soil is very poor in any one constituent one or two years may settle the question, but if in fair or good condition a longer time will surely be necessary. Fortunately, those whose land is already in good condition will care, less than others, for such a test.

Three plots like those above described, each 27 by 27 feet wide and separated by paths 6 to 8 feet wide will usually serve the purpose well. They should be manured as follows:

1	8 lbs. sodium nitrate. 10 lbs. dissolved boneblack.
2	8 lbs. sodium nitrate. 5 lbs. muriate of potash.
3	5 lbs. muriate of potash. 10 lbs. dissolved boneblack.

If a fourth plot is employed, it should receive the following:

4	8 lbs. sodium nitrate. 10 lbs. dissolved boneblack. 5 lbs. muriate of potash.

In case a fifth plot is used it should receive no manure whatever. If it is desired to combine a lime test with the preceding, a sixth plot could be used, which should be manured exactly like the fourth except that 60 to 70 pounds of air-slacked lime should be added and thoroughly worked into the soil. For such a soil test which does not include the lime test, Indian corn, rye or oats may be used, perhaps to the best advantage, though when combining it with a lime experiment beets or barley should be substituted. Great care must be taken that in the operations of tillage the soil of one plot is not dragged over upon another. Wherever it is possible one crop should first be grown without any manure for the purpose of ascertaining if the soil is satis-

factorily uniform for the experiment. Sometimes a former manure pile, hay stack, or a chance bonfire may have so enriched the soil on some small spot that it will produce good crops for years, while practically nothing is produced a few feet away. Such a spot if falling in one of the experiment plots might lead to the most erroneous conclusions unless the above-mentioned precaution were taken.

IN RELATION TO SPECIAL FERTILIZERS FOR SPECIAL CROPS.

There is good ground for the compounding of special fertilizers for special crops, yet this idea has doubtless been carried to excess by certain manufacturers, though probably more for the sake of meeting competition than for any other reason. This is a fact much to be regretted for it adds needlessly to the expense of manufacturing, and is paid for by the farmer. It is also true that if the fertilizer requirements of soils are known, special formulas can be employed to suit their particular needs, whereby greater economy can be effected. This latter point can be determined by the farmer for himself by the method outlined on page 97, though not without some special effort on his part. If chemical methods can be found for determining *in a satisfactory manner* the particular needs of our soils which have been long under cultivation, then one great drawback to the compounding of fertilizers to meet the needs of special soils will be effectually removed and the farmer will be relieved of the necessity of making soil tests with fertilizers. In certain sections soil tests have already revealed the special soil requirements, and in others practical experience with commercial fertilizers has demonstrated to some extent in what ingredient the soils are chiefly deficient. It is claimed by Whitcher that New Hampshire soils require a greater proportion of potash than is generally found in commercial fertilizers. Experiments by Prof. Goessmann, at Amherst, Mass., also point in the same direction, and the farmers of Long Island and many of those upon the Island of Rhode Island in this State also hold that sufficient potash is not supplied in many of the brands of commercial fertilizers and particularly in those intended for the production of potatoes. One or more soil tests with fertilizers have already been conducted by this Station in each county in the State, and with two or three exceptions, the results were satisfactory. These trials which were made in co-operation with the farmer have

shown that old pastures and mowing lands, particularly where the soil is light, are more deficient in phosphoric acid than in nitrogen or potash. For the production of Indian corn upon such soils the greatest profits were not realized when the largest yields were produced, but rather from moderate crops. There is a maximum limit of production for all plants and in order to approach that limit closely the soil must be in the most favorable condition, both physically and so far as concerns moisture, *and an abundance of each of the essential elements must be present in assimilable form.* In endeavoring to provide this last condition there cannot fail to be a loss of fertilizing material, for not all of it will be used by the plant and subsequent loss by leaching will ensue. In the experiments thus far conducted by this Station there appears to be a limit for Indian corn, beyond which it is not profitable to advance. This is particularly true in relation to the use of nitrogen, largely on account of its cost. The results thus far obtained indicate that for Indian corn planted on freshly-turned sod in good condition, the use of much nitrogen is not attended by profit. Where there is only a light sod as is too often the case on our light sandy loam soils a larger proportion of nitrogen should be used.

It should be distinctly understood by farmers that all nitrogenous fertilizers go to waste if crops are not kept growing continuously while the weather permits, and from the end of one growing season to the beginning of the next, great losses of nitrogen doubtless result even where slowly nitrifiable nitrogen in form of blood, fish, etc., is employed. Phosphoric acid passes continually into less soluble combinations, and even potash is liable to loss to some extent by leaching. Under such circumstances the absurdity of applying fertilizers in quantities much more than sufficient for the immediate crop must be evident, and the quicker those farmers who have been brought up to the idea of storing up fertility for future crops, come to a realization of the fact that such a plan is not the most rational one to employ in the use of commercial fertilizers the better it will be for them. Probably, however, the fault of many in connection with the use of commercial fertilizers in this State, is that they use too little per acre. The labor involved in caring for a poor crop is about as great as in caring for a good one.

Under the barnyard manure system seeding down without subsequent top-dressing of grass lands though not an ideal practice, was formerly generally attended with profit, and it is a hard

matter for those once accustomed to such a system to adopt that of annual top-dressing of grass lands with chemicals or commercial fertilizers, yet it must be evident to everyone familiar with the direct losses of and the natural changes in assimilability of the fertilizing elements, that the use of a small amount of certain kinds of fertilizer at the time of seeding and a resort to annual top-dressing, is the only rational way in which to manure grass lands when chemicals are employed. Attention should be called again, at this point, to the fact that even an abundance of potash, phosphoric acid and nitrogen may fail to give good crops of many kinds, including clover, Timothy, Kentucky blue grass and perhaps other grasses, provided the soil is decidedly acid and a consequent deficiency of calcium carbonate exists. If such is the case this condition can probably be most quickly determined by the test with blue litmus paper, and by that with beets and lime, outlined on page 96. The evidence at hand is sufficient to conclude, wherever in Rhode Island lime benefits the growth of beets in a marked manner under the exact conditions outlined in the test, that clover and the above-mentioned grasses will probably be helped by it also. It may be stated that Timothy and clover could not be produced with profit on the Experiment Station farm until air-slacked lime was used in connection with the three so-called essential elements, potash, phosphoric acid and nitrogen. Large quantities of stable manure, owing to its alkalinity, would, if applied annually, relieve the acid condition, yet it is not so lasting in its effects as lime, and unless produced without much cost or purchased at a low price, it would not prove economical on decidedly acid soils ; indeed this fact is laid down by Ruffin in a work treating of the light soils of Virginia over a half century ago. Ruffin found those soils entirely lacking in calcium carbonate and concluded, probably rightly, from this fact and the abundant growth of sorrel, wild grass and pines that the soil was acid, though he evidently was not aware of, or at least never used, the litmus paper, or any other practical tests for disclosing it. The less quantity of stable manure at disposal on such soils the more benefit from lime will be observable, or in other words, if lime is used, much greater results would be expected from small quantities of stable manure. Under all circumstances where lime is used, a supply of humus should be maintained in the soil, and this may be done by the employment of stable manure, sea-weed or muck, or by turning under an occasional green crop or grass sod.

The value of meadow muck in connection with the use of lime ought to be particularly emphasized for the improvement of light, sandy soils of the state. The value of lime seems evident from the long after-effect noticeable when wood ashes have been used, and the value of muck particularly upon such soils is attested by all who have tried it. The fact is, however, too little appreciated that each of these materials when used in connection with the other is more effective than when applied alone, and the same is true of the combination of the two when used in connection with commercial fertilizers.

FERTILIZER FORMULAS.

It is not expected in this bulletin to give a formula for each crop grown, but rather to put in the hands of the farmers of the State some formulas particularly adapted to certain classes of plants and for use under the varying conditions arising in actual farm practice. Most of the formulas which we give are such as have been tested in a practical way by farmers themselves. Some formulas will contain cotton-seed meal as one of their constituents, yet if the price of this material happens to be high, tankage or fish should be substituted, if low, as was the case in the spring of 1895, then it is a most desirable material to employ. No man who expects to be successful would go on the plan of using a certain constituent *regardless of its cost*, even though it had given good results heretofore, so that at its best such information as can be given here must be supplemented by common sense and judicious purchases on the part of the farmer, if the best results are to be secured.

FORMULAS FOR POTATOES AND VEGETABLES.

The following is a formula which has been used by the Narragansett Grange, G. R. Hicks of Bristol Ferry, and others. It has been sold by certain parties, either mixed or unmixed, with a charge of $3 per ton for mixing:

Blood, bone and meat (tankage or animal dust)	750 lbs.
Dissolved boneblack	750 "
Muriate of potash	200 "
High grade sulphate of potash	200 "
Nitrate of soda	100 "
Total	2000

A slight modification of this formula, that is, with two pounds more of dissolved boneblack and 25 pounds more of nitrate of soda, was used with satisfactory results by Joseph A. Tillinghast, of Summit, R. I., in *1891*. He did the mixing and sent a sample of the mixture to this Station for analysis with the result given below. J. T. G. Sweet, of Slocumville, used the same formula in *1894*, and the analysis of the mixture, which he sent to this Station, is also given.

	Hicks' 1893 mixture. Per cent.	Tillinghast's mixture. Per cent.	Sweet's mixture. Per cent.
Water	9.03	11.23	12.57
Nitrogen in nitrates	.82	.95	.97
Nitrogen in ammonia salts	.00	.09	.00
Nitrogen in organic matter	2 78	2.26	2.01
Total nitrogen	3.60	3 30	2.98
Soluble phosphoric acid	6.86	6 67	7.04
Reverted " "	1.53	3.56	2.97
Insoluble " "	1 04	1.50	1.34
Available " "	9.43	10.23	10 01
Total " "	8 39	11.73	11.35
Potash	8.38	9 00	8.02
Chlorine	5.68	4.51	5.30
Valuation	$31 16	$35 43	$29 88
Cost	35 00	36 00	.....

More or less variation in the composition of the mixtures is noticeable, but it should be borne in mind that fertilizers mixed according to the same formula, no matter how uniformly the mixing is done, are apt to show variations in composition from year to year, owing to unavoidable differences in the composition of the tankage and of some of the other materials of which they are made. Of course the farmer can protect himself in this respect if he will, by taking note of the guaranteed composition of the stock which he buys.

Hicks' mixture cost more than it should. By the use of a cheaper form of phosphoric acid equally good results might have been obtained that season at less cost. In the formulas above given it will be noticed that muriate and sulphate of potash were both used, and some farmers are of the opinion that a combination of the two forms is desirable for potatoes. It is well known that chlorine lowers the quality of potatoes, and the chlorine is introduced in the muriate of potash. High grade sulphate of potash produces potatoes of better quality but it is a more expensive form

of potash, so that for all other vegetables with the exception perhaps of table beets, in which sweetness is desired, the muriate of potash is recommended as the most economical form to apply. In either of the above formulas like weights of muriate of potash and of *high grade* (48 per cent. potash) sulphate of potash may be substituted for each other.

The following formula was used by Joseph A. Peckham, of Middletown, R. I., in 1893:

	Pounds.
Muriate of potash	319
Nitrate of soda	178
Dry ground fish	382
Tankage	306
Dissolved phosphate rock	382
Dissolved boneblack	178
Fine ground bone	255
Total	2000

Had more dissolved phosphate rock been used in the place of the dissolved boneblack it would have been cheaper and probably equally effective. A sample of the mixture was analyzed at the Station with the following result:

	Per cent.
Water	10.87
Nitrogen in nitrates	1.55
" " ammonia salts	0.00
" " organic matter	2.58
Total nitrogen	4.13
Soluble phosphoric acid	3.63
Reverted " "	2.47
Insoluble " "	4.27
Total " "	10.31
Available " "	6.10
Potash	9.33
Chlorine	8.62
Valuation	$31.60
Cost	32.13

The high insoluble phosphoric acid was due to the bone and fish, forms which are sooner decomposed in the soil than those frequently present in ready mixed goods.

The following formulas were used by the Portsmouth Grange in 1894:

FORMULA NO. 1.

	Pounds.
Dissolved phosphate rock	800
Fine ground tankage or animal dust	650
High grade sulphate of potash	400
Nitrate of soda	150
Total	2000

FORMULA NO. 2.

	Pounds.
Dissolved phosphate rock	400
Dissolved boneblack	300
High grade sulphate of potash	400
Muriate of potash	100
Fine ground tankage or animal dust	650
Nitrate of soda	150
	2000

Formula No. 2 might, at the prices paid at that time, have been mixed more cheaply by substituting dissolved phosphate rock for the dissolved boneblack. If one were to grow potatoes for quantity regardless of quality some expense could be saved, as heretofore intimated, by using equal weights of muriate of potash in place of the sulphate. In practical trials in comparison with commercial fertilizers, Mr. I. L. Sherman reported that the results were as good or better than with commercial ready-mixed goods. Samples of the above mixture were forwarded by I. L. Sherman on behalf of Portsmouth Grange, and were analyzed at this Station with the following results:

	Formula No. 1.	Formula No. 2.
Water	9 00	9.85
Nitrogen in nitrates	1.21	1.34
" in ammonia salts	.00	00
" in organic matter	1.42	1.16
Total nitrogen	2.63	2.50
Soluble phosphoric acid	6.00	5.94
Reverted " "	2.28	2 21
Insoluble " "	2.75	2.38
Available " "	8.28	8.15
Total " "	11.03	10.53
Potash	10 06	12 25
Chlorine	1.32	3.40
Valuation	$29 78	$30 88
Cost per ton including freight	28 50	31 25

These goods caked a little, which was the only difficulty reported, and the results from their use were very satisfactory. At least the satisfaction given with the mixed goods was such that the quantity of material purchased in 1895 was over seventy tons instead of a few tons as in 1894.

In 1895 some slight modifications were made in the formulas employed with the hope of preventing caking. It will be seen that they contain more nitrogen than those of 1894, and they were prepared with that end also in view:

FORMULA "NO. 1 A."

	Pounds.
Dissolved phosphate rock	800
"Blood" tankage	700
Nitrate of soda	100
High grade sulphate of potash	200
Muriate of potash	200
	2000

FORMULA "NO. 2 B."

	Pounds.
Dissolved phosphate rock	450
Dissolved boneblack	400
"Blood" tankage	700
Nitrate of soda	100
High grade sulphate of potash	150
Muriate of potash	200
	2000

FORMULA "NO. 2 D."

	Pounds.
Dissolved phosphate rock	450
Dissolved boneblack	400
Tankage	500
Dry fine ground fish	200
Nitrate of soda	100
High grade sulphate of potash	150
Muriate of potash	200
	2000

The members of the Grange in this case sent a man to the factory to see the goods mixed and bagged, instead of mixing them themselves. The party from whom the goods were bought guar-

anteed that they should have a certain composition, and an agent of this Station sampled each lot upon its arrival, both parties agreeing to abide by the results of the Station analyses. The following shows the composition of the goods:

Formulas { Station No / Grange No	207 No. 1 A.	208 No. 2 B.	209 No. 2 D.
Water	8.34	10.19	10.44
Nitrogen in nitrates	.82	.81	.76
" " ammonia salts	.00	.00	.00
" " organic matter	2.74	2.50	2.62
Total nitrogen	3.56	3.31	3.38
Soluble phosphoric acid	4.12	6.06	6.32
Reverted " "	2.80	1.54	2.16
Insoluble " "	2.64	2.17	1.87
Available " "	6.92	7.60	8.48
Total " "	9.56	9.77	10.35
Potash	9.97	9.52	9.65
Chlorine	5.20	5.28	5.36
Cost per ton including freight and the expense of sending a man to the factory.	$29.00	$29.50	$29.50
Valuation per ton	30.01	29.47	30.70

The cost and valuation of these and all the other goods enumerated in this article should be compared with the cost and valuation of the regular commercial fertilizers sold in the state, bearing in mind that the basis of valuation is exactly the same in each case.

The following formulas were used in 1895 by Jos. A. Peckham, of Middletown, R. I., and G. R. Hicks, Bristol Ferry, R. I.:

JOS. A. PECKHAM'S FORMULA.

	Pounds.
Dissolved phosphate rock	850
Tankage	300
Dry fine ground fish	400
Nitrate of soda	100
High grade sulphate of potash	150
Muriate of potash	200
	2000

These materials were purchased from the same party and practically under the same conditions as those by the Portmouth Grange. Mr. Peckham wanted more fish than was contained in their formula No. 2 D, and modified it accordingly.

G. R. HICKS' FORMULA.

	Pounds.
Nitrate of soda	100
Dry ground fish	250
Tankage	400
Dissolved boneblack	500
Dissolved phosphate rock	450
Muriate of potash	300
	2000

Mr. Peckham's goods were sampled by an agent of this Station, at the same time that those of the Portsmouth Grange were sampled, and Mr. Hicks sampled his own.

Upon analysis in our Station laboratory the following results were obtained:

Station No.	210 Peckham's formula. Per cent.	211 Hicks' formula. Per cent.
Water	9.07	10.37
Nitrogen in nitrates	.93	.85
" in ammonia salts	.00	.00
" in organic matter	2.88	2.41
Total nitrogen	3.81	3.26
Soluble phosphoric acid	4.30	6.56
Reverted " "	3 29	1.78
Insoluble " "	2.81	1.75
Available " "	7.59	8.34
Total " "	10.40	10.09
Potash	8.84	7.71
Chlorine	5.04	*
Cost	†$29 25	‡$31 00
Valuation	30 47	27 97

The results secured with these formulas are referred to in the first pages of this article and were, as may be seen, very satisfactory.

* In excess of the amount of potash.

† Not including about one dollar for local freight.

‡ The estimated cost of mixing was $1.00 additional. It will be seen that the cost of this fertilizer was greater than it should have been, and it may have been due in part to the use of dissolved boneblack, which was not so economical at last year's prices as the dissolved phosphate rock. In purchasing, farmers should secure quotations from a number of dealers and buy where the goods are offered at the lowest price, provided, of course, that the guaranteed quality is right and the parties are reliable.

OTHER FORMULAS FOR POTATOES AND VEGETABLES WHICH HAVE BEEN USED WITH SUCCESS.

Formulas containing cotton-seed meal.

During the spring of 1895 cotton-seed meal could have been bought at from $19 to $21 per ton, at which price it was one of the most economical nitrogenous fertilizer constituents on sale. This fact was recognized by many farmers of the State and numerous demands for fertilizer formulas containing it were received.

The following represents the average composition of 28 samples of cotton-seed meal analyzed at the Massachusetts State Experiment Station.*

	Per cent.
Nitrogen	6.67
Potash	1.71
Phosphoric acid	1.59

The above will show that it is essentially a nitrogeneous material to which potash and phosphoric acid must be added in order to make a fertilizer adapted to general purposes. Its nitrogen is also not so quick in its action as that in nitrate of soda, so that if immediate effects are desired some of the latter compound should be introduced.

The following formula cost $26 per ton, including $1.50 for mixing. The party who used it thought that more potash would have been an improvement, and this change could be easily effected by introducing 50 to 100 pounds more of muriate of potash and leaving out a like amount of cotton-seed meal.

FORMULA.

	Pounds.
Dissolved phosphate rock	850
Nitrate of soda	150
Muriate of potash	300
Cotton-seed meal	700
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.5
Potash	8
Available phosphoric acid	6

* 12th Annual Report, 1894, page 423.

The following formula was for a party who wished to use sulphate of potash for the sake of the better quality of his potato tubers. He also desired to use sulphate of ammonia and dissolved boneblack, both of which increased the cost much above what it would have been had nitrate of soda and dissolved phosphate rock been substituted. Of course the prices a year hence may be such that the formula as given would be cheaper than the modification proposed. This merely illustrates the fact that the market prices of the stock to be used should control largely what shall be employed in a mixture :

FORMULA.

	Pounds.
High grade sulphate of potash	325
Nitrate of soda	100
Sulphate of ammonia	100
Dissolved boneblack	750
Cotton-seed meal	725
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.0
Potash	8.0
Available phosphoric acid	7.0

The following formula was designed for use where a good quality of tubers was desired and was, at the ruling prices in the spring of 1895, very cheap :

	Pounds.
Cotton-seed meal	800
High grade sulphate of potash	400
Nitrate of soda	100
Dissolved phosphate rock	700
	2000

At last spring's prices the dissolved phosphate rock could have been left out and one-third as much of double superphosphate, containing 33 to 40 per cent. of soluble phosphoric acid, introduced. Thus a slight reduction in expense might have been made.

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.4
Potash	10.2
Available phosphoric acid	5.2

The following formula contains a large amount of nitrogen in the form of nitrates. The bone adapts it well for use for vegetables having a long period of growth, or where successive crops are to be grown in one season and the land subsequently seeded down:

FORMULA.

	Pounds.
Muriate of potash	400
Dissolved phosphate rock	500
Nitrate of soda	250
Fine ground bone	400
Cotton-seed meal	450
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.9
Nitrogen as nitrates	1.9
Potash	10.2
Available phosphoric acid	5.5

Potato and Vegetable Formulas Containing Fish and Tankage instead of Cotton-Seed Meal.

The following is a formula compounded and used by S. Sanford, of Portsmouth, R. I., in 1894:

FORMULA.

	Pounds.
Dissolved phosphate rock	890
Tankage	550
Muriate of potash	450
Nitrate of soda	110
	2000

Cost including freight, $29.15 per ton.

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	2.5
Potash	11.1
Available phosphoric acid	7.2

Mr. Sanford became convinced that the above formula contained too little nitrogen for his soil, and in 1895 he used the following combination:

	Pounds.
Nitrate of soda	150
Sulphate of ammonia	100
Dried blood	450
Muriate of potash	400
Dissolved phosphate rock	900
	2000

It is stated that this formula could have been bought for cash including freight for $32.50. Nitrogen in the form of dried blood and particularly in sulphate of ammonia was much more costly last season than that in the form of nitrate of soda, cotton-seed meal and tankage, which made this formula less economical than some of the others. With this formula a very satisfactory growth of tops was obtained and the results seemed promising, but owing to the early blighting the yield was very seriously reduced.

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.6
Potash	10.0
Available phosphoric acid	5.8

Mr. F. M. Wood, of Harrisville, R. I., has employed the following formula for potatoes:

FORMULA.

	Pounds.
High grade sulphate of potash	360
Dissolved phosphate rock	550
Tankage	730
Fine ground bone	120
Nitrate of soda	120
Dried blood	120
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.9
Potash	8.6
Available phosphoric acid	6.

E. G. Macomber, of Portsmouth, R. I., has made various changes in the formulas which he has used from year to year and the following represents the ideal which he has reached in 1895. He states that he uses only guaranteed standard high grade materials in which he has confidence.

FORMULA.

	Pounds.
Fine ground bone	400
Dissolved boneblack	400
Dry ground fish	300
Cotton-seed meal	300
Nitrate of soda	200
Sulphate of potash	200
Muriate of potash	200
	2000

Cost per ton, $32.90, not including mixing.

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.0
Potash	10.0
Available phosphoric acid	6.4

Very excellent results are claimed for this formula for potatoes and vegetables in rotation with cereals and grass. Mr. Macomber mixes but 500 pounds of the above formula at each mixing, and instead of *weighing* out each time the amount of the materials to be mixed, he uses boxes gauged to hold approximately the right weights. For mixing he employs a device which may be described as follows: A large hopper or funnel-shaped receiver projects through an opening in the barn floor, and the constituents to be mixed are dumped into this hopper and passed through a churn-like arrangement hung in a frame which stands on the cellar floor. This mixer is supported on gimbals as is a ship's compass. By means of removable levers which can be attached to one set of the trunions the mixer is first revolved in one direction and then by applying them to the other set located at right angles to the first, a revolution, also at a right angle to the first, may be effected. The material is finally drawn out of the bottom of the mixer and bagged. This apparatus has been in use by Mr. Macomber four seasons, and he claims that the work can be done with it both quickly and satisfactorily. He makes a special point of the fact that much of the dust which arises when fertilizers are mixed by shovelling may thus be avoided. The estimated cost of mixing by the aid of this apparatus is fifty cents per ton.

J. S. Madison, of East Greenwich, R. I., has used the following formula for potatoes with good results:

	Pounds.
Dissolved boneblack	570
Tankage	760
High grade sulphate of potash	430
Sulphate of ammonia	140
Nitrate of soda	100
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.5
Potash	10.3
Available phosphoric acid	6.7

This formula could have been made in 1895 at a less cost by the use of either double superphosphate or dissolved phosphate rock in place of the dissolved boneblack, and by replacing the sulphate of ammonia entirely by nitrate of soda. By these changes the fertilizer would probably not have proved in any respect less effective.

FORMULA FOR ONIONS.

The following formula has been proposed for onions, but we do not know that it has had a trial.

	Pounds.
Muriate of potash	400
Dissolved phosphate rock	550
Tankage	500
Fine ground bone	200
Nitrate of soda	350
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.4
Potash	10.0
Available phosphoric acid	5.9

This formula contains about 2.1 per cent. of phosphoric acid in the form of bone and tankage in addition to the 5.9 per cent. of available phosphoric acid above given.

FORMULAS FOR GENERAL PURPOSES.

The following is a formula which has been used by Joseph A. Tillinghast, of Summit, R. I.:

	Pounds.
Nitrate of soda	125
Tankage	750
Dissolved boneblack	725
Muriate of potash	400
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.2
Potash	10.0
Available phosphoric acid	8.0

Formulas for General Purposes, using Air-Dry Hen Manure as a basis.

	Pounds.
Air-dry hen manure	1330
Dissolved phosphate rock	530
Muriate of potash	140
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	2.0
Potash	4.5
Available phosphoric acid	5.1

FORMULAS FOR INDIAN CORN.

The following formula has been used by Francis M. Wood, of Harrisville, R. I., who reports excellent results from it:

	Pounds.
Dissolved bone	920
Nitrate of soda	330
Tankage	550
Muriate of potash	200
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	5.1
Potash	5.0
Available phosphoric acid	8.3

Dissolved bone is frequently sold at so high a price that it would be better economy to omit its use and substitute a little extra nitrate of soda to supply the nitrogen, and dissolved bone-black, dissolved phosphate rock or double superphosphate to

furnish the phosphoric acid. The decision as to which of these sources of soluble phosphoric acid to use should be based wholly upon the market value at any particular time since by the change indicated an equally effective fertilizer would be produced.

The following is a formula used by Joseph A. Tillinghast, of Summit, R. I. It was particularly intended for Indian corn on a sandy loam pasture:

	Pounds.
Muriate of potash	360
Dissolved boneblack	1090
Nitrate of soda	550
	2000

ESTIMATED ANALYSIS.

	Per cent.
Notrogen	4.2
Potash	9.0
Available phosphoric acid	9.2

The following is another formula which was designed by Mr. Tillinghast for Indian corn on an old pasture having a light sandy loam soil, and known to be very deficient in phosphoric acid:

	Pounds.
Nitrate of soda	200
Tankage	700
Double superphosphate	700
Muriate of potash	400
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.7
Potash	10.0
Available phosphoric acid	15.8

Half a ton of this formula was used per acre for Indian corn, variety, Longfellow, and the yield was stated to have been much above the average. Mr. Tillinghast also adds that it made an excellent top-dressing for meadows and that 2000 pounds per acre produced a yield of 280 bushels per acre of potatoes on an old sandy loam pasture.

The following formula was compounded for use in East Greenwich on sandy loam soil:

	Pounds.
Nitrate of soda	250
Muriate of potash	300
Dissolved phosphate rock	1200
Cotton-seed meal	250
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	2.8
Potash	7.7
Available phosphoric acid	8.0

Formula for Indian corn with air-dry hen-manure as a basis:

	Pounds.
Air-dry hen manure	1190
Dissolved phosphate rock	710
Muriate of potash	100
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	1.8
Potash	3.4
Available phosphoric acid	6.0

The foregoing formulas for Indian corn cover a wide range as far as concerns chemical composition, and some one of them can be selected which is adapted to practically any soil in the State. On *old light sandy loam pasture* those formulas containing a high percentage of available phosphoric acid and a fair amount of nitrogen will doubtless prove to be most economical. Where there is a good turf and the soil is heavier less nitrogen is usually required.

FORMULA FOR MILLET AND HUNGARIAN.

The following is a formula for millet and Hungarian which was used by S. W. Thayer, of Bristol, R. I., in 1895:

	Pounds.
Dissolved phosphate rock	900
Nitrate of soda	200
Muriate of potash	300
Cotton-seed meal	600
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.5
Potash	8.0
Available phosphoric acid	6.3

On old pasture land in poor condition, probably better returns would be obtained by substituting a little nitrate of soda and a considerable amount of dissolved phosphate rock for a portion of the cotton-seed meal.

FORMULA FOR BARLEY.

This formula has been used by Francis M. Wood, of Harrisville, R. I., who reports favorably of it:

	Pounds.
Dissolved bone	930
Muriate of potash	220
Tankage	380
Nitrate of soda	470
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	5.2
Potash	5.5
Available phosphoric acid	7.9

FORMULA FOR SPINACH, LETTUCE, CABBAGES AND CUCUMBERS.

We have had no report of results from the use of this formula:

	Pounds.
Muriate of potash	370
Nitrate of soda	500
Dissolved phosphate rock	590
Cotton-seed meal	540
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	5.6
Potash	9.7
Available phosphoric acid	4.2

On poor soil an additional application of dissolved phosphate

rock, double superphosphate, dissolved bone or dissolved bone-black, would doubtless be beneficial.

FORMULA FOR ASPARAGUS.

This formula is the one used by Mr. C. W. Prescott, of Concord, Mass., whose report is given on page 90 :

	Pounds.
Nitrate of soda	370
Muriate of potash	630
Fine ground bone	1000
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.9
Potash	15.8
Available phosphoric acid	5.5
Total phosphoric acid	11.0

Mr. Prescott states that he varies this formula by reducing the amount of bone and increasing the quantity of nitrate of soda.

FORMULAS FOR SEEDING DOWN AND TOP DRESSING.

It will be obvious that an entirely different formula should be used for seeding to grass in the spring than for seeding in the autumn. Spring seeding is generally done in connection with a grain crop, and consequently a sufficient amount of immediately assimilable potash, phosphoric acid and nitrogen should be used, to insure an ample supply to the grain crop, and in case it seemed advisable a small quantity of top-dressing mixture could be applied after the removal of the grain crop, though this is perhaps seldom necessary or advisable. The following and each successive spring, however, the top-dressing mixture may be used in small quantities just as the grass begins to start. This is a practice too little followed in this State. In the case of fall seeding the nitrate of soda may be omitted from the formula, provided the land is in good condition, though if in poor condition or if scantily fertilized previously, a small amount of nitrate of soda might be advisable. Grass makes a rapid growth in the spring and consequently the materials used for top-dressing should be in such a form that they are immediately assimilable, and because they are

in this condition they should not be applied late in the autumn. If it is intended to top-dress at any other time than in the spring it should usually be done immediately after the removal of a crop and if possible just before a rain.

The following formula is one well designed for spring seeding, and it has been used by Joseph A. Tillinghast, of Summit, R. I., at the rate of 1000 pounds per acre with good results:

	Pounds.
Muriate of potash	200
Nitrate of soda	200
Cotton-seed meal	600
Dissolved phosphate rock	500
Fine ground bone	500
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	4.0
Potash	5.5
Available phosphoric acid	6.4

This formula contains considerable phosphoric acid in the form of bone, which is not included in the available phosphoric acid but which would gradually become assimilable.

FORMULA FOR FALL SEEDING.

This formula was compounded for Mr. C. A. Brayton, of Fiskeville, R. I., in the fall of 1895, so that no results from its use can be reported at this time:

	Pounds.
Nitrate of soda	50
Muriate of potash	200
Dissolved phosphate rock	400
Fine ground bone	700
Tankage	650
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	3.0
Potash	5.0
Available phosphoric acid	8.0

In case the land was in good condition or the previous crop had been well manured in the spring immediately preceding, then the 50 pounds of nitrate of soda might be omitted, or in case the land was very poor and little or no fertilizer had been used in connection with the preceding, then 100 pounds of nitrate of soda could perhaps be introduced to advantage, and this is particularly true if the seeding is done in the late summer or very early autumn. It should be stated that the above formula contains in addition to that above mentioned, about 5.5 per cent. of phosphoric acid in form of bone, which would become gradually assimilable.

FORMULA FOR THE SPRING TOP-DRESSING OF GRASS LANDS OR WINTER RYE.

This formula was compounded for W. King & Son, of Kenyon, R. I., who report good results from its use:

	Pounds.
Nitrate of soda	300
Dissolved phosphate rock	1480
Muriate of potash	220
	2000

ESTIMATED ANALYSIS.

	Per cent.
Nitrogen	2.3
Potash	5.5
Available phosphoric acid	9.6

ON THE EFFECT OF WOOD ASHES AS A FERTILIZER AND THE SUPPLEMENTARY CONSTITUENTS WHICH SHOULD BE USED IN CONNECTION WITH THEM.

We find that farmers in most sections of Rhode Island esteem wood ashes highly as a manure, and they seem in many localities to hold a rank next to barnyard manure. From repeated inquiries made in many sections of the State it appears that the beneficial effect of wood ashes is, almost without exception, attributed to the direct manurial action of the potash which they contain, yet it is usual to hear that the effects from a single application are often visible for from ten to fifteen years. When we consider, however, that 100 bushels of ashes weighing about 4500 pounds would, upon the average basis of 5 per cent. of potash, contain but 225 pounds of actual potash, which is equivalent to

but 450 pounds of muriate of potash, it would seem at least astonishing that an after-effect from such an application should be visible for from ten to fifteen years unless it were due in a considerable measure to something other than the small amount of potash which they contain. An application of a ton of potato or vegetable fertilizer containing 10 per cent. of potash would supply 200 pounds of potash, equivalent to 400 pounds of muriate of potash, or an amount nearly equal to that supplied by 4500 pounds of wood ashes, and yet we practically never hear of any long continued after effect from the use of muriate or sulphate of potash, or of chemical fertilizers which contain them. Wood ashes contain on an average about 1.5 per cent. of phosphoric acid, which would amount to an application of 67.5 pounds of phosphoric acid for each 4500 pounds of wood ashes, an amount equivalent to what would be furnished by about 300 pounds of fine ground bone. Now if the action of the ashes is based upon the combined direct manurial effect of the potash and phosphoric acid, then 450 pounds of muriate of potash and 300 pounds of ground bone would be expected to exert an effect analogous to that obtained from the wood ashes. As a matter of fact we believe that the farmers of Rhode Island and many other parts of New England have obtained results with wood ashes which are not due to, and which doubtless would not be attainable, by the use of the quantities of muriate of potash and bone above mentioned. It would appear to be equally unsatisfactory to attribute the beneficial action of wood ashes solely to the small quantities of magnesia, soda, or whatever else they may contain, regardless of the lime. The experiments thus far conducted at this Station as well as others at Hope Valley and Westerly, together with experiments by farmers in West Kingston, Usquepaugh, and several localities without the State, point strongly to the value of lime on many soils, not only as direct plant food but also in putting the soil into a condition suitable for the growth of certain plants, and into such a condition that the nitrogenous plant food stored up in the soil, as well as that in the organic nitrogen and ammonium sulphate employed, may exert its maximum effect. In this connection also the well-known value of lime in improving the physical condition of sandy as well as clayey soils should not go unmentioned. In other words, our experience and observation in this State lead us to believe that the chief cause of the long-continued after-effect of wood ashes is the *lime* which they contain,

and not the potash, as has been heretofore generally supposed. Certainly if such is the case, it behooves the farmers of the State to try the lime experiment outlined on page 97 for the purpose of testing this question, for the same amount of lime and other fertilizing elements which the wood ashes contain can be purchased in other, probably equally effective forms, at a lower price.

It will be evident from what has just been said that wood ashes contain but little phosphoric acid, and it is also true that they contain no nitrogen. Therefore, if they are to be used on a rational and economical basis they must be supplemented by phosphatic and nitrogenous fertilizers.

The following materials used upon one acre would be about equivalent, so far as concerns potash, phosphoric acid and nitrogen, to one ton of a fertilizer containing 10 per cent. of potash, 6.5 per cent. of available phosphoric acid, and 4 per cent. of nitrogen:

	Pounds.
Wood ashes	4,000
Dissolved phosphate rock	1,000
Nitrate of soda	510

Practically the same amount of lime and other ingredients would be contained in the following:

	Pounds.
Air-slacked lime (70 per cent. lime, CaO)	2,000
Dissolved phospate rock	1,460
Muriate of potash	400
Nitrate of soda	510

SEA-WEED AND THE SUPPLEMENTARY FERTILIZERS WHICH IT REQUIRES.

In Bulletin 21 of this Station, January, 1893, we published analyses of the more important varieties of sea-weeds which are used for manurial purposes along our coast. In the course of this work it was plainly shown that sea-weed is distinctively a nitrogenous and potassic fertilizer, or in other words, that *it is relatively deficient in phosphoric acid*, so that bone, slag meal, and dissolved phosphates of various kinds suggest themselves as the proper supplements for land where sea-weed has long been used. We take occasion to call attention to this point once more with the belief that if it were sufficiently recognized, more satisfactory and economical results would be obtained from the use of sea-

weed. It would probably be well worth the trouble for those farmers who have used sea-weed to lay out two small plots of land, leaving one without any fertilizer except the sea-weed, and to the other add some dissolved phosphate rock and compare the results. Such an experiment involves no particular expense and may prove of great value.

BARNYARD MANURE AND THE SUPPLEMENTARY FERTILIZERS WHICH IT REQUIRES.

Barnyard manure contains relatively more nitrogen than potash, and is notably deficient in phosphoric acid, so that if the manure is to be used on the most economical basis a small amount of potash and a much larger quantity of phosphoric acid should be used in connection with it. Owing to the great variation in the composition of such manure depending upon the cattle food used, the care of the manure and the amount of foreign matter mixed with it, no attempt to give the exact amounts for use will be made. A motto in relation to manures which should find its place on every farm would read somewhat as follows: *Save what you have, supplement it wisely and buy economically.*

Any of the following substitutions may be made in the preceding formulas without materially changing the amounts of nitrogen, available phosphoric acid and potash.

For 100 lbs. of nitrate of soda, either 76 lbs. of sulphate of ammonia, 141 lbs. of dried blood, or 235 lbs. cotton-seed meal.

For 100 lbs. of sulphate of ammonia, either 132 lbs. of nitrate of soda, 186 lbs. of dried blood, or 311 lbs. cotton-seed meal.

For 100 lbs. of dried blood, either 71 lbs. of nitrate of soda, 54 lbs. of sulphate of ammonia, or 167 lbs. cotton-seed meal.

For 100 lbs. cotton-seed meal, either 43 lbs. nitrate of soda, 32 lbs. sulphate of ammonia, or 60 lbs. dried blood.

For 100 lbs. dissolved phosphate rock, either 76 lbs. of dissolved boneblack, or 33 lbs. of double superphosphate.

For 100 lbs. of dissolved boneblack, either 131 lbs. of dissolved phosphate rock, or 43 lbs. of double superphosphate.

For 100 lbs. of double superphosphate, either 308 lbs. of dissolved phosphate rock, or 235 lbs. of dissolved boneblack.

For 100 lbs. of tankage, either 39 lbs. of nitrate of soda and 38 lbs. of dissolved phosphate rock, 29 lbs. sulphate of ammonia, and 38 lbs. dissolved phosphate rock, 55 lbs. dried blood and 38 lbs. dissolved phosphate rock, 91 lbs. cotton-seed meal and 38 lbs. dissolved phosphate rock, 80 lbs. of dry ground fish and 14 lbs. of dissolved phosphate rock, or 45 lbs. fine ground bone and 33 lbs. nitrate of soda.

For 100 lbs. dry ground fish, either 48 lbs. nitrate of soda and 31 lbs. dissolved phosphate rock, 37 lbs. sulphate of ammonia and 31 lbs. dissolved phosphate rock, 68 lbs. dried blood and 31 lbs. dissolved phosphate rock, 113 lbs. cotton-seed meal and 31 lbs. dissolved phosphate rock, 80 lbs. tankage and 17 lbs. nitrate of soda, or 36 lbs. fine ground bone and 44 lbs. nitrate of soda.

For 100 lbs. fine ground bone, either 13 lbs.. nitrate soda and 85 lbs. dissolved phosphate rock, 10 lbs. sulphate of ammonia and 85 lbs. dissolved phosphate rock, 18 lbs. dried blood and 85 lbs. dissolved phosphate rock, 30 lbs. cotton-seed meal and 85 lbs. dissolved phosphate rock, 33 lbs. tankage and 72 lbs. dissolved phosphate rock, or 27 lbs. dry ground fish and 76 lbs. dissolved phosphate rock.

For practical purposes muriate and high grade (48 to 50 per cent.) sulphate of potash may be substituted, each for the other, in equal quantities; in replacing either of these by low grade sulphate, (double sulphate of potash and magnesia), double the quantity should be used or in replacing either by kainit, four times the amount should be used.

In the above calculations the basis of composition used was, for dried blood 11 per cent. of nitrogen, for tankage 6 per cent. of nitrogen and 5 per cent. of available phosphoric acid; for fish, 7.5 per cent of nitrogen and 4 per cent. of available phosphoric acid, and for fine ground bone, 2 per cent. of nitrogen and 11 per cent of available phosphoric acid.

As a general rule if dissolved phosphate rock containing between 12 and 13 per cent. of soluble phosphoric acid can be bought at $15 per ton, that is about the same from the farmer's

standpoint as dissolved boneblack at $19.50 per ton, *or for a rule that will fit all cases, multiply the price of dissolved phosphate rock by 1.3, and if the result is above the price at which dissolved boneblack is offered, then buy the latter, if the result falls below the quotation for dissolved boneblack then take the former. If double superphosphate can be bought at three times, or less than three times, the cost of dissolved phosphate rock, then it is usually more economical than the latter.*

MACOMBER'S MACHINE FOR THE HOME-MIXING OF FERTILIZERS.

CHARLES O. FLAGG.

On page 112 of this Bulletin mention is made of a machine constructed by Mr. E. G. Macomber, of Portsmouth, and used by him with perfect satisfaction for four years in the home-mixing of fertilizers. By its use chemicals and fertilizers of various kinds are thoroughly mixed at a cost of about fifty cents per ton. Fine ground bone and other dusty materials can be perfectly mixed without raising clouds of dust as is the case in mixing them with shovels on the barn floor. In connection with the subject matter of this Bulletin it was thought worth while to obtain photographs and measurements of the machine, from which the illustrations herewith have been prepared. Mr. G. E. Adams found difficulty in photographing the machine, as it stands in a barn cellar for convenient use,—a difficult place in which to secure good photographs. Two views are given: Fig. 1 represents the churn-like receptacle in a horizontal, and Fig. 2 in a vertical position; the latter shows the opening through which the fertilizer is removed. When the fertilizer is mixed the machine is fastened so that the opening is at the bottom and the mixed fertilizer is drawn off into bags, the latter being held by an ingeniously arranged rod at the opening. The chemicals are introduced through a hole six inches square in the middle of the top of the mixer which is closed by a sliding board. Five hundred pounds of fertilizer can be mixed at one time, and about fifteen minutes is required for the operation. Four men are required to turn the mixer with that quantity of fertilizer, two at each end of the mixer. For half the time stated the mixer is revolved upon one axis, and then the arms are removed and slipped over the hubs or trunions of the other axis, and it is revolved in a direction at right angles with the previous revolution for the remainder of the time. The chemicals are weighed or measured on the barn floor above the mixer. Boxes of different sizes are used for measures, their capacity having first been determined by filling and weighing them. The

FIG. 1. MACOMBER'S FERTILIZER MIXER.
Horizontal Position.

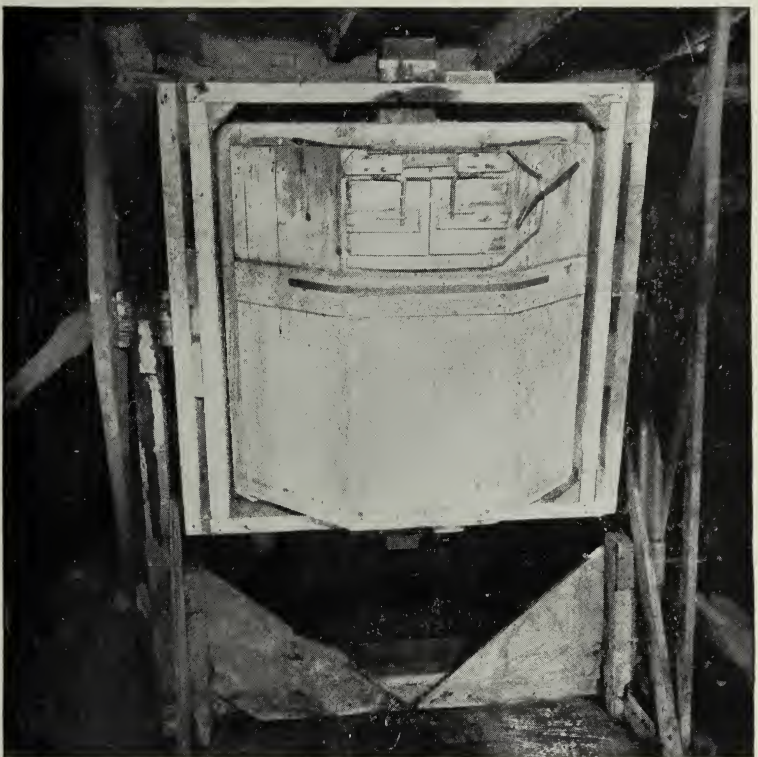
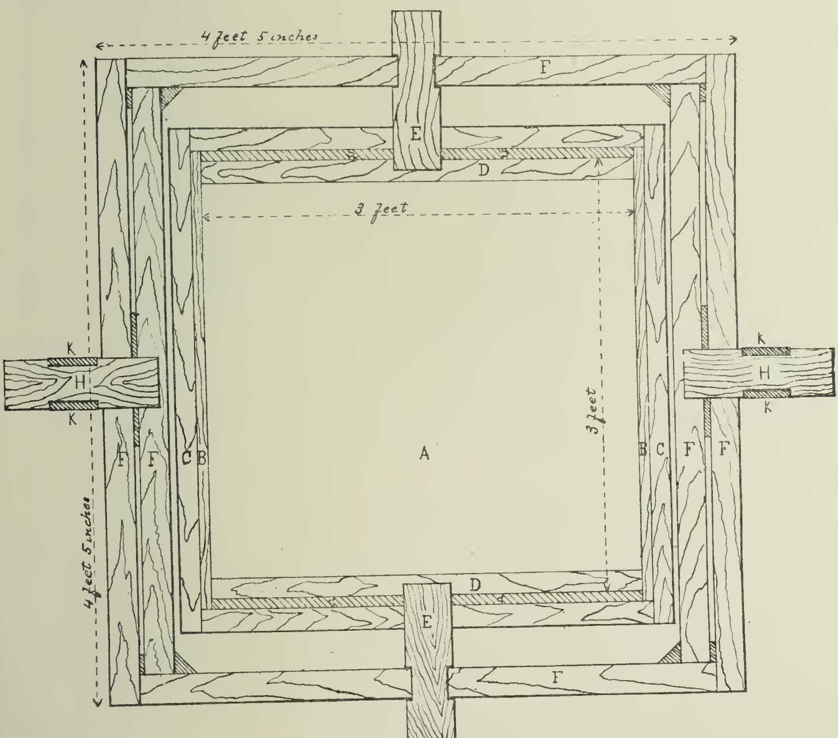


Fig. 2. Macomber's Fertilizer Mixer.
Vertical Position.

proper proportion of the various ingredients for five hundred pounds of mixed fertilizer is then quickly measured out and poured into a hopper, from which it passes through the floor and down through a spout made of bagging into the mixer. The hopper is five feet square at the top, and when in place is about two feet above the floor. Each set of levers or "arms" is made of two pieces of $2\frac{1}{2}$ x 8 in. plank, 6 feet in length, halved together at right angles and fastened with spikes. A hole four inches square is mortised through the center so that it can be easily slipped from one trunion to the other. The ends of the arms are cut down to a convenient size for grasping with the hands in revolving the mixer. Two upright pieces of 4 x 4 in. joist, securely braced, support the mixer and frame in which it is hung. The tops of these are cut out to make the bearings for the trunions or wooden axles of the frame. The distance from the floor to the center of the trunions is four and one-half feet. The mixer is octagonal in its cross section, three feet inside diameter, and three feet long.



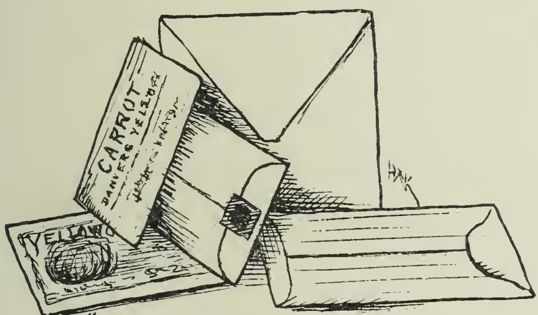
The diagram, Fig. 3, represents a horizontal section through the trunions when the mixer is in the position shown in Fig. 1.

(A) is the mixer, 3 x 3 feet inside measurement, made of tongued and grooved pine boards (BB) seven-eighths of an inch thick. Across the inside of each end at the center is spiked a 2 x 8 in. plank (DD) and a belt of the same (CC) extends around the middle of the mixer to make the trunions (EE) secure and sustain the weight. Greater strength could perhaps be secured by extending an axis through the mixer with trunions at each end, but Mr. Macomber has found by trial that it interferes with perfect mixing and makes more work in clearing out the fertilizer. The trunions (EE and HH) are pieces of 4 x 4 in. joist. (EE) are securely mortised into the center of the ends of the octagonal mixer (A), and are turned down to about three inches in diameter where they rest in the outer frame. The outer frame (FF) is made of pieces of plank 2½ in. thick and 10 in. wide, securely spiked together, and is 4 ft. 5 in. square measured on the outside. The two sides of this frame which are mortised for the trunions (HH), are made of two thicknesses of plank, separated by short strips of board so as to give a mortise of sufficient depth to hold the trunions securely in place and sustain the required weight. The trunions (HH) are of the same size as (EE) with the bearing turned down to the same diameter. They revolve in the hollowed ends (KK) of the two upright 4 x 4 in. joists previously mentioned. The trunions project sufficiently to receive the levers or arms already described, and are each bound with a band of strap iron to prevent wear and splitting. When the mixer is revolved by placing the levers upon the trunions (EE), the outer frame (FF) is held in a horizontal position by a temporary leg at one corner held in place by a pin. When mixer and frame are revolved upon the trunions (HH), the mixer is clamped to the outer frame by a button at one end.

Bulletin 35. December, 1895

KINGSTON, RHODE ISLAND.

GARDEN SEEDS.



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Agricultural Experiment Station

OF THE

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*Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island

GARDEN VEGETABLE SEEDS.

L. F. KINNEY AND G. E. ADAMS.

INTRODUCTION.

This is a period in which we are looking for improvements in horticultural matters. Vegetable growers want to know how they can conduct their affairs more prudently. The facts given in this Bulletin seem to be sufficient to prove that the purchase of vegetable seeds without requiring on the part of the dealer some assurance that a fair proportion of them are alive and are capable of growing, if placed under favorable conditions, is a careless practice. Because it is a practice that is common to all purchasers of vegetable seeds it is the more important. It certainly is not necessary that dealers should sell seeds with a very low per cent. of vitality if they exercise proper care in testing their stock. The devitalizing process does not go on rapidly under ordinary conditions, but unless purchasers require dealers to attend to this important duty they may suffer the consequences. How this can best be brought about is a question for vegetable growers and others who use seeds to answer. It is a matter which clearly affects their interests, and one that is worthy of their attention. It would seem to us that the best way to do this would be by *judicious* legislation that would protect the purchaser of seeds somewhat in the same manner as the present fertilizer law protects the purchaser of fertilizers, although perhaps the same object can be secured by other means.

THE QUALITY OF GARDEN SEEDS.

The cost of the seed is but a fractional part of the cost of a vegetable garden, but the quality of the seed is a matter of fundamental importance which should not be underestimated by planters. The color of the outer coat of a seed may be bright and the kernel full and yet the seed be worthless for planting purposes.

That worthless seeds do find their way into the markets and that they are annually purchased by gardeners in considerable quantities and at the price of good seeds there is no doubt. Those who have had experience in the use of garden seeds know very well that their quality, as they are at present sold in this State, cannot be depended upon, and yet the facts in the possession of such individuals are not sufficient to prove to persons less familiar with the subject that a reform is needed.

In order to supply planters with information that is both exact and comprehensive in character, this matter has been made a subject of inquiry at this station. It is believed that the data obtained will prove of value to vegetable growers who should realize that losses which follow the failure of crops, whether due to use of poor seed or other causes, affect the prosperity of their business as much or more than gains that are secured from remarkably large crops.

UNEVEN POWER OF GERMINATION.

This is a common fault with garden seeds and one which is the cause of much vexation among vegetable growers who purchase their supply of seeds annually from seed dealers. It appears to be due, largely at least, to the sale of seeds of different ages, although the conditions under which seed is grown and kept affect its vitality. Garden seeds differ from wine in that they are not improved by keeping.

OLD GARDEN SEEDS.

These need not be condemned, but the dealer should guarantee their vitality. It is well known that under favorable circumstances garden seeds may remain good for several years ; but their vitality will gradually decrease, and when it has reached a certain limit they should no longer be sold as first class seeds, although after this they could properly be sold under a low guarantee and at a proportionately low price. The purchaser would then know that he was buying second quality seed and could plant it accordingly.

VITALITY TESTS.

Simple tests of the vitality of seeds may be made by individual purchasers, and if sufficient care is exercised the results obtained

may be accurate enough for ordinary purposes. But as a matter of practice these tests are often not satisfactory, and this is probably the reason why the average vegetable grower prefers to plant his seeds and if they fail to grow to bear the consequences.

SEED CONTROL STATIONS.

In Europe the need of placing some restrictions on the seed business has been recognized for many years, and now in all of the principal countries seed control stations have been established. The number of these stations doing active work outside of the United States has been given as 117.* Of these about forty are in Germany. In some cases the control is brought about by legislative action requiring all seed offered for sale to be equal to or above a certain standard quality. In others the same end is secured by mutual agreement between the wholesale dealers and the stations. In the latter case the stations certify to the quality of the seed placed upon the market. It is said that the quality of the seed sold in Europe has steadily improved since the general adoption of the control methods.

INVESTIGATION OF THE QUALITY OF GARDEN SEEDS OFFERED FOR SALE IN RHODE ISLAND IN THE SPRING OF 1895.

A standard variety of each of thirteen kinds of common vegetable seeds was chosen for this purpose. Then nineteen representative seed dealers were selected. Eleven of these are local dealers and eight are non-resident but sell more or less seeds in the state annually in original packages. So far as possible one sample of each of the varieties included in the investigation was purchased from each of the nineteen dealers, but in a comparatively few cases where the particular variety wanted was not kept in stock another was substituted for it or it was omitted from the list. Altogether 233 samples of seeds were obtained strictly in accordance with the plan described, and these only will be considered in the following pages, although other samples of garden seeds have been examined at different times. These seeds were

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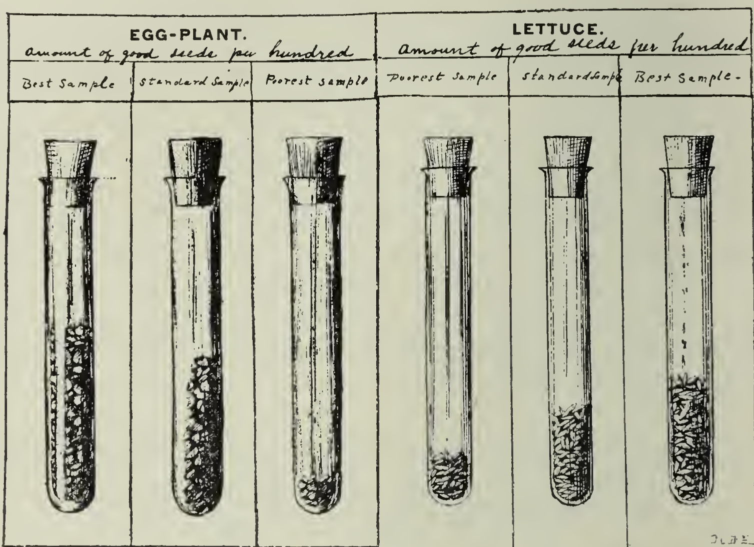
* Experiment Station Record, Vol. VI, p. 945.

purchased during the latter part of March and the first part of April, 1895, by Mr. Adams, whose connection with the Station was unknown to the dealers. At this time the seed market was at its best. It was early in the season and no attempt was made to secure anything but seeds of the best quality that the dealers had for sale.



SEED VIALS.

EXAMINATION OF SAMPLES.

This work was carefully done to determine the proportion of impurities by weight which each sample contained, and it may be said here that the amount found was very small. This is shown by the following figures:

141	samples	had	only 1 per cent or less of impurities.						
68	"	"	more than	1	per cent.	but not	above	3	per cent. of impurities.
18	"	"	"	3	"	"	"	5	" "
3	"	"	"	5	"	"	"	10	" "
2	"	"	"	10	"	"	"	15	" "
1	"	"	"	15	"	"	"	20	" "

In no case was there any indication that impurities had been intentionally introduced to adulterate the seed and further it was evident that, with the exception of a few samples of the carrot, considerable care had been exercised in cleaning the seed.

SPROUTING TESTS.

These were the tests which showed the uneven value of the different lots of seed for planting purposes. The difficulties that may arise from planting seed of unknown quality are illustrated in Figs. 1, 2 and 3, where the same number of radish seeds was sown in each pan. Eight months before the seeds were sown tests showed the vitality of the lots from which they were taken to be as follows:

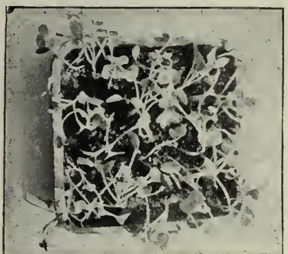


FIG. 1, PAN A.
Too many Plants.

FIG. 2, PAN B.
Right number of Plants.

FIG. 3, PAN C.
Not enough Plants.

Those sown in pan A, 98 per cent. good.
" " B, 73 " "
" " C, 29 " "

Deterioration in vitality evidently did not go on as fast in the lot of seed from which those in pan A were taken as in the other two, although the seeds were kept under precisely the same conditions. This may have been due to the different ages of the seeds. It is what might have been expected to occur if it had been known that those in the first lot were new seeds and that the others were old.*

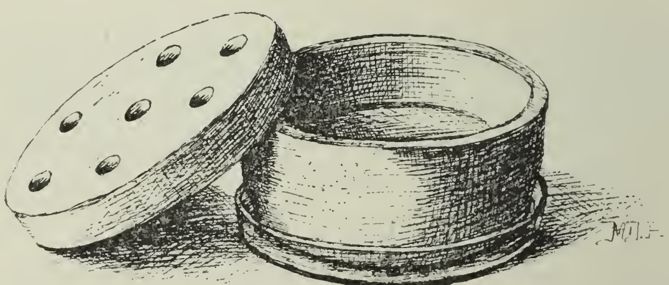
* To learn how rapidly the devitalizing process progressed, Prof. Nobbe made annual tests from the same packages of various seeds from 1870 to 1874, and the results in the case of Red Clover were found as follows: Average of 32 samples, 1870, 87 per cent.; 1872, 70 per cent.; 1873, 53 per cent.; 1874, 43 per cent.; (Bul. 108, N. C. Expt. Sta., p. 380.)

METHODS USED IN MAKING SPROUTING TESTS.

As representative a sample as could be secured, consisting of two hundred seeds, was taken from each lot purchased. These samples were then divided into two equal parts of one hundred seeds, which were kept separate afterwards, one acting as a check upon the other during the test. When all the samples of a particular kind of seed were thus prepared and placed in separate cups they were put into a sprouting chamber where a nearly uniform temperature and humidity of the atmosphere was maintained for fourteen days. The temperature of the chamber during the different tests was as follows:

Onions	65°	Fahr.
Cabbage, Carrot, Celery, Lettuce, Parsnip, Radish	70°	"
Beet	75°	"
Cucumber, Egg Plant, Tomato, Turnip	80°	"
Pepper	85°	"

These temperatures are given by the North Carolina Experiment Station* after the collection of data from many sources, as the optimum germination temperatures of these seeds. Each day during the time that the seeds were in the sprouting chamber they were examined and all that showed well defined sprouts were counted and removed from their respective cups. Finally at the end of fourteen days all seeds that had not sprouted but remained sound and those that had softened during the time were counted and the records completed. Later the records of the two samples of each lot were compared and an average of the two considered as the result of the test.



SPROUTING CUP.

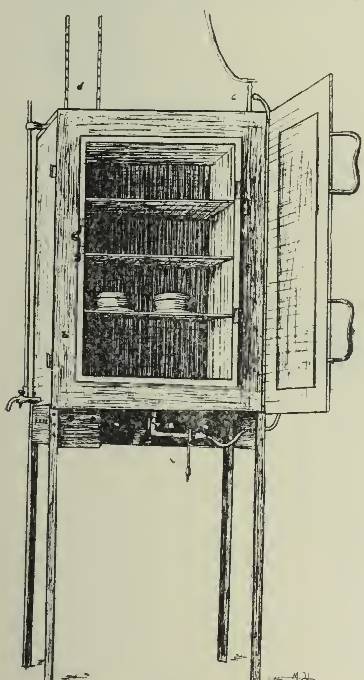
*Bul. 108, pp. 384, 385.

SPROUTING CUPS.

These were made for this Station out of porous clay by A. H. Hews & Co., of North Cambridge, Mass., the pattern being much like that used at the Seed Control Station at Zurich, Switzerland. They are three inches in diameter and one and three-fourths inches high, including the cover which is ventilated as shown in the figure. The bottom is solid and one-half inch thick. Each cup is placed in a glass dish in which a constant supply of water is kept.

SPROUTING CHAMBER USED IN THE TESTS.

This holds about fifty cups. Heat is supplied by a gas jet, which is supported beneath the chamber, and it is distributed evenly to all sides of the chamber, except the front, by means of a water-jacket. It is provided with two doors, the inner one being glass. There is an opening in the side and top for ventilating, and a second opening in the top for the insertion of a thermometer. There are also two openings into the water-jacket at the top. In one of these a thermostat (c) is placed, which controls the flow of gas at the jet beneath, and in the other a thermometer (d) may be placed to show the temperature of the water in the jacket.



SPROUTING CHAMBER.

TABLE SHOWING THE NAMES OF THE SEED DEALERS FROM WHOM SEEDS WERE OBTAINED, THE NUMBER OF SAMPLES OBTAINED FROM EACH, AND THE QUALITY OF THE SEEDS AS COMPARED WITH A PROPOSED LABORATORY STANDARD* FOR GOOD SEEDS OF THE SPECIES:

NAMES OF DEALERS.		No. of samples tested.	No. equal to or above the proposed standard of merchantable seeds of the species.	No. below the proposed standard of merchantable seeds of the species.
Richard Barnett	Woonsocket, R. I.	9	2	7
W. E. Barrett & Co	Providence, R. I.	13	6	7
A. F. & F. Bray	Pawtucket, R. I.	13	4	9
W. A. Burpee & Co	Philadelphia, Pa.	13	6	7
John Lewis Childs	Floral Park, N. Y.	13	7	6
Henry A. Dreer	Philadelphia, Pa.	14	8	6
D. M. Ferry & Co	Detroit, Mich.	13	9	4
Jas. J. H. Gregory & Son	Marblehead, Mass	12	8	4
Halliday Bros	East Providence, R. I.	13	7	6
Peter Henderson & Co	New York, R. I.	13	6	7
E. M. Lyman & Sons	Springfield, Mass	12	1	11
Commission seeds purchased of J. A. Allen, Peace Dale, R. I.				
W. A. Munroe	Providence, R. I.	12	5	7
Wm. Henry Maule	Philadelphia, Pa.	13	7	6
Walter A. Potter & Co	Providence, R. I.	16	6	10
Jerome B. Rice & Co	Cambridge, N. Y.	8	2	6
Commission seeds purchased of R. P. Brooks, Harrisville, R. I.				
W. R. Sharpe	East Greenwich, R. I.	13	9	4
J. C. Tucker, Jr.	Wakefield, R. I.	11	5	6
Geo. A. Weaver & Co.	Newport, R. I	13	7	6
C. W. Willard	Westerly, R. I.	9	4	5

*Bulletin No. 108, North Carolina Experiment Station, pp. 384, 385.

TABLES SHOWING THE WEIGHT OF THE SEEDS, THE AMOUNT AND NATURE OF THE IMPURITIES PRESENT, THE NUMBER OF SEEDS THAT GERMINATED WITHIN FOUR DAYS AND IN FOURTEEN DAYS, THE NUMBER OF DAYS REQUIRED FOR ONE-HALF THE SAMPLE TO GERMINATE, THE NUMBER OF HARD SEEDS THAT REMAINED, AND THE VALUATION PER CENT.*

Station number.	BEET (SEED IN POD).	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
61	Early Eclipse, Dreer	1.791	0.5	59	112	13	83.67	5	Inert matter.
84	Eclipse, Sharpe	1.825	0.7	127	132	8	98.54	2	Weed seeds.
86	Eclipse, Henderson	1.443	0.44	87	126	9	94.2	4	Broken seeds.
112	Eclipse, Weaver	1.7325	1.6	57	112	11	82.76	7	Inert matter.
141	Eclipse, Burpee	1.4995	0.34	83	115	6	86.06	4	"
155	Eclipse, Childs	1.4375	0.7	71	126	4	93.95	4	"
167	Eclipse, Maule	1.436	2.1	43	62	27	45.94	....	"
179	Eclipse, Ferry	1.606	3.64	60	112	4	81.04	5	"
191	Eclipse, Tucker	1.72	1.2	42	94	11	69.74	11	"
198	Eclipse, Lyman	1.514	0.1	81	126	8	94.5	4	"
208	Eclipse, Willard	1.412	2.58	55	88	3	64.37	5	"
221	Eclipse, Barnett	1.576	2.	58	112	9	82.42	5	Broken seeds, chaff.
229	Eclipse, Rice	1.16	2.5	46	108	11	79.07	6	Inert matter.
241	Eclipse, Bray	1.738	0.2	48	86	10	64.45	9	"
244	Eclipse, Barrett	1.361	0.3	40	107	6	80.06	7	"
264	Eclipse, Halliday	1.4585	1.6	52	93	7	68.62	5	"
279	Eclipse, Munroe	1.2635	2.9	35	95	3	69.27	6	Broken seeds.
282	Eclipse, Potter	1.275	0.3	32	106	4	79.35	6	Inert matter.
289	Edmands Blood, Potter	1.719	4.8	87	95	3	67.91	3	Broken seeds.

* The valuation per cent. is calculated by multiplying the vitality per cent. by the purity per cent. and dividing the product by one hundred.

Station number.	CABBAGE.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One half of sample sprouted in days.	NATURE OF IMPURITIES.
64	Jersey Wakefield, Dreer	0.369	0.00	84	94	1	94.	3	None.
78	Jersey Wakefield, Sharpe	0.463	0.00	74	83	5	83.	2	"
96	Jersey Wakefield, Henderson	0.3895	0.00	80	83	3	83.	1	"
102	Jersey Wakefield, Weaver	0.3755	0.00	86	93	2	93.	2	"
122	Jersey Wakefield, Gregory	0.361	0.00	78	95	1	95.	2	"
136	Jersey Wakefield, Burpee	0.3275	0.00	97	97	0	97.	1	"
150	Early Wakefield, Childs	0.376	0.2	95	97	0	96.8	1	Broken seeds.
158	Prize Wakefield, Maule	0.396	0.4	96	96	0	95.6	1	"
172	Jersey Wakefield, Ferry	0.463	0.00	98	98	0	98.	1	None.
188	Jersey Wakefield, Tucker	0.461	0.0)	98	98	0	98.	1	"
197	Jersey Wakefield, Lyman	0.375	0.00	56	64	0	64.	4	"
206	Jersey Wakefield, Willard	0.3085	0.00	93	95	0	95.	2	"
217	Jersey Wakefield, Barnett	0.372	0.95	23	60	5	59.43	8	Foreign seeds.
243	Jersey Wakefield, Bray	0.446	1.8	88	92	0	90.34	2	Inert matter.
250	Jersey Wakefield, Barrett	0.49	0.44	90	91	0	90.59	1	"
259	Jersey Wakefield, Halliday	0.4075	0.18	94	95	0	94.82	1	Broken seeds.
271	Jersey Wakefield, Munroe	0 405	0.00	94	95	0	95.	1	None.
291	Jersey Wakefield, Potter	0.338	0 00	98	99	0	99.	1	"

Station number.	CARROT.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
56	Danvers Half Long, Dreer	0.147	4.	40	55	31	52.8	6	Inert matter.
82	Danvers, Sharpe	0.115	3.9	72	83	9	79.76	3	Broken seeds and chaff.
85	Danvers, Henderson	0.122	3.3	71	92	2	88.96	3	Inert matter.
107	Danvers Half Long, Weaver	0.1515	2.9	46	56	23	54.37	5	"
115	Danvers, Gregory	0.122	0.2	76	87	12	86.82	3	"
135	Danvers, Burpee	0.1525	2.9	39	51	25	49.52	6	Broken seeds and stems.
153	Danvers Half Long, Childs	0.1515	2.1	31	55	16	53.84	7	Inert matter.
164	Maule's Danvers, Maule	0.111	3.5	37	67	1	64.65	6	"
178	Danvers, Ferry	0.0905	3.2	81	93	3	90.02	3	"
192	Danvers, Tucker	0.148	3.7	26	51	32	49.11	8	Broken seeds and dirt.
199	Danvers Orange, Lyman	0.108	7.6	33	51	1	47.12	9	Inert matter.
205	Half Long Danvers, Willard	0.1345	3.84	38	57	12	55.21	5	Undeveloped seeds.
216	Danvers, Barnett	0.106	2.3	77	94	3	91.83	4	Inert matter.
223	Danvers, Rice	0.153	7.4	16	51	12	47.22	11	"
242	Danvers, Bray	0.124	11.	27	47	25	41.83	...	Inert matter and undeveloped seeds.
254	Danvers, Barrett	0.1245	16.75	33	39	13	32.46	....	Broken seeds and dirt.
267	Danvers, Halliday	0.126	1.9	73	85	10	83.38	4	Inert matter.
272	Danvers, Munroe	0.192	12.2	75	81	13	71.11	3	Undeveloped seeds.
287	Guerande, Potter	0.134	5.8	74	81	1	76.3	3	Broken seeds.
288	Danvers, Potter	0.1345	3.25	28	48	7	46.44	...	"

Station number.	CELERY.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
63	White Plume, Dreer	0.0585	0.3	0	39	0	38.88	....	Inert matter.
83	White Plume, Sharpe	0.0465	1.75	0	3	8	2.94	....	"
97	White Plume, Henderson	0.061	1.9	0	2	7	1.96	....	"
103	White Plume, Weaver	0.0445	1.5	0	12	4	11.82	....	"
123	White Plume, Gregory	0.055	1.4	0	18	0	17.75	....	"
139	White Plume, Burpee	0.0385	1.5	0	25	11	24.62	....	"
146	White Plume, Childs	0.039	0.7	0	9	16	8.93	....	"
157	White Plume, Maule	0.052	1.2	0	20	8	19.64	....	"
176	White Plume, Ferry	0.0555	1.	0	28	14	27.72	....	"
182	White Plume, Tucker	0.0445	1.2	0	9	13	8.89	....	"
203	Dwarf White Solid, Lyman	0.0405	1.	0	0	5	0.00	....	"
211	White Plume, Willard	0.0385	1.5	0	0	0	0.00	....	"
227	White Plume, Rice	0.054	0.4	0	12	17	11.95	....	"
235	White Plume, Bray	0.0425	0.5	0	27	20	26.86	....	"
253	White Plume, Barrett	0.061	0.5	0	1	7	.99	....	"
257	White Plume, Halliday	0.054	0.5	0	1	10	.99	....	"
270	White Plume, Munroe	0.0435	0.35	0	17	15	16.94	....	"
292	White Plume, Potter	0.0635	1.25	0	0	10	0.00	....	"

Station number.	CUCUMBER.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
60	White Spine, Dreer	2.739	0.0	84	84	0	84.	2	....
74	White Spine, Sharpe	2.204	1.6	96	96	0	94.46	2	Flesh of the cucumber.
89	White Spine, Henderson	2.369	0.2	92	94	0	93.81	2	" "
110	White Spine, Weaver	2.595	0.5	94	96	0	95.52	2	" "
124	White Spine, Gregory	2.857	0.3	97	97	0	96.7	1	Inert matter.
130	White Spine, Burpee	2.081	2.08	71	72	0	70.5	2	Flesh of the cucumber.
154	Early Green Cluster, Childs	2.702	0.2	86	90	0	89.82	2	" "
163	Extra Long White Spine, Maule	2.787	0.0	88	92	1	92.	2	None.
171	Early White Spine, Ferry	2.4735	0.5	96	96	0	95.52	1	Flesh of the cucumber.
186	White Spine, Tucker	2.415	0.0	92	92	0	92.	1	None.
201	Early White Spine, Lyman	2.551	0.1	80	80	0	79.92	2	Dust.
210	White Spine, Willard	2.6575	0.0	99	99	0	99.	2	None.
214	White Spine, Barnett	2.6585	0.2	97	97	0	96.8	1	Inert matter.
228	White Spine, Rice	2.447	0.0	91	91	0	91.	2	None.
240	White Spine, Bray	2.735	0.0	76	76	0	76.	2	"
252	White Spine, Barrett	2.83	0.0	86	87	0	87.	1	"
258	White Spine, Halliday	2.653	0.1	97	97	0	96.9	1	Dust.
277	White Spine, Munroe	2.581	0.2	76	76	0	75.84	2	Inert matter.
285	White Spine, Potter	2.4625	0.0	30	34	0	34.	....	None.

Station number.	EGG PLANT.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
62	N. Y. Purple Improved, Dreer	0.491	0.2	1	48	31	47.09	....	Dirt.
80	Improved N. Y. Spineless, Sharpe	0.4375	2.1	0	69	17	68.55	13	Broken seeds.
93	N. Y. Improved, Henderson	0.4325	1.	0	72	15	71.28	13	Flesh of the egg plant.
106	N. Y. Improved, Weaver	0.4725	1.	2	61	25	60.39	14	Broken seeds.
116	N. Y. Improved, Gregory	0.413	0.6	1	35	22	34.79	....	"
132	N. Y. Improved, Burpee	0.3775	0.0	16	74	12	74.	6	None.
145	Hallock's N. Y. Improved, Childs	0.484	0.1	0	67	18	66.93	14	Inert matter.
162	N. Y. Improved, Maule	0.39	0.0	5	12	68	12.	....	None.
175	Improved Large Purple, Ferry	0.445	1.5	27	81	16	79.78	8	Broken seeds.
213	Early Long Purple, Willard	0.369	2.5	4	12	13	11.7	....	Inert matter.
237	N. Y. Improved, Bray	0.445	0.5	25	53	12	52.73	14	Broken seeds.
246	N. Y. Improved, Barrett	0.449	1.4	7	72	11	70.99	13	Inert matter.
262	N. Y. Improved, Halliday	0.411	1.35	1	26	17	25.64	....	"
294	N. Y. Improved, Potter	0.471	1.5	53	74	10	72.89	4	Broken seeds.

Station number.	LETTUCE.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
69	Royal Cabbage, Dreer	0.161	0.0	98	98	0	98.	1	
57	Boston Market, Dreer	0.1215	2.3	100	100	0	97.7	1	Inert matter.
81	Boston Market, Sharpe	0.1285	2.2	95	97	0	94.86	1	Chaff.
91	Boston Market, Henderson	0.118	1.5	94	96	0	94.56	1	Broken seeds.
101	Boston Market, Weaver	0.113	1.5	76	80	4	78.8	1	Trash.
118	White Tennis Ball, Gregory	0.102	1.	94	97	0	96.3	1	Inert matter.
134	Boston Market, Burpee	0.124	2.7	97	99	0	96.32	1	Broken seeds and chaff.
149	Boston Fine Curled, Childs.	0.0995	1.4	32	69	8	68.03	5	Inert matter.
161	Big Boston, Maule	0.109	0.5	31	91	2	90.54	6	"
170	Big Boston, Ferry	0.1335	3.	11	99	0	96.03	5	"
185	Boston Market, Tucker.	0.1145	1.66	95	95	0	93.4	2	Chaff.
200	Early Boston Market, Lyman.	0.086	3.4	50	76	0	73.41	4	Inert matter.
219	Boston Market, Barnett	0.152	0.7	5	33	13	32.76	....	"
233	Boston Market, Bray	0.116	2.4	10	47	5	45.87	....	Chaff.
251	Boston Tennis Ball, Barrett	0.131	1.35	2	69	0	68.07	9	Broken seeds.
269	Tennis Ball, Halliday	0.14	1.35	2	77	14	75.96	9	"
281	New York, Munroe	0.1435	0.5	5	94	3	93.53	5	Chaff.
286	Brown Dutch, Potter	0.147	1.	8	41	17	40.59	...	Foreign seeds.
290	Boston Market, Potter	0.12	1.45	3	75	14	73.9	8	Broken seeds.

Station number.	ONION.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
58	Yellow Globe Danvers, Dreer	0.365	0.0	56	91	2	91.	3	None.
72	Yellow Globe Danvers, Sharpe	0.3355	0.0	67	87	4	87.	3	"
94	Yellow Globe Danvers, Henderson	0.335	0.3	69	83	5	82.75	3	Inert matter.
105	Yellow Globe Danvers, Weaver	0.321	0.1	67	84	0	83.91	4	"
120	Yellow Globe Danvers, Gregory	0.347	0.0	70	92	1	92.	3	None.
138	Yellow Globe Danvers, Burpee	0.356	0.0	70	92	2	92.	3	"
147	Yellow Globe Danvers, Childs	0.378	0.2	77	92	2	91.81	3	Inert matter.
160	Yellow Globe Danvers, Maule	0.376	0.2	75	90	3	89.82	3	"
174	Yellow Globe Danvers, Ferry	0.387	0.1	56	93	2	92.9	4	"
187	Yellow Globe Danvers, Tucker	0.3305	0.0	80	91	0	91.	3	None.
195	Yellow Globe Danvers, Lyman	0.368	0.0	47	60	13	60.	...	"
207	Yellow Globe Danvers, Willard	0.325	0.2	81	92	2	91.81	3	Inert matter.
220	Yellow Globe Danvers, Barnett	0.3385	0.5	36	41	7	40.79	..	"
224	Yellow Globe Danvers, Rice	0.338	0.1	55	82	4	81.91	4	"
239	Yellow Globe Danvers, Bray	0.375	0.9	56	76	2	75.31	4	Broken seeds.
245	Yellow Globe Danvers, Barrett	0.3435	0.7	85	92	1	91.35	3	Inert matter.
268	Yellow Globe Danvers, Halliday	0.39	0.0	62	92	3	92.	4	None.
276	Yellow Globe Danvers, Munroe	0.359	0.2	61	74	5	73.85	4	Inert matter.
297	Yellow Globe Danvers, Potter	0.362	1.2	18	60	24	59.28	7	Broken seeds.

Station number.	PARSNIP.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
65	Student, Dreer	0.494	1.32	0	43	24	42.43	....	Inert matter.
73	Hollow Crown, Sharpe	0.464	0.4	0	80	6	79.68	8	"
87	Hollow Crown, Henderson	0.3935	0.78	0	34	8	33.73	....	"
109	Hollow Crown, Weaver	0.487	1.3	0	24	7	23.68	..	"
125	Abbott's Hollow Crown, Gregory	0.4185	1.1	0	69	9	68.24	11	"
137	Improved Guernsey, Burpee	0.3375	0.8	0	73	13	72.41	9	"
152	Improved Guernsey, Childs	0.386	1.1	0	68	15	67.25	9	"
168	Improved Long Smooth, Maule	0.445	1.	0	67	12	66.33	11	"
177	Guernsey, Ferry	0.456	1.34	0	70	8	69.06	12	"
190	Hollow Crown, Tucker	0.406	1.14	0	34	5	33.61	....	"
193	Long Smooth White, Lyman	0.4235	1.4	0	4	4	3.94	...	"
222	Hollow Crown, Barnett	0.4675	1.1	0	50	17	49.45	13	"
236	Hollow Crown, Bray	0.358	0.3	0	61	4	60.81	10	"
256	Hollow Crown, Barrett	0.44	3.5	0	54	7	52.11	12	"
263	Hollow Crown, Halliday	0.4485	3.4	0	32	15	30.91	....	"
275	Guernsey, Munroe	0.46	3.8	0	30	12	28.86	...	"
283	Hollow Crown, Potter	0.4125	2.	0	34	5	33.32	....	"

Station number.	PEPPER.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
66	Sweet Mountain, Dreer	0.68	0.	2	47	24	47.	....	None.
75	Sweet Mountain, Sharpe	0.579	1.85	7	53	22	52.01	14	Broken seeds.
95	Large Bell, Henderson	0.6745	1.3	2	62	19	61.19	13	Flesh of pepper.
104	Sweet Mountain, Weaver	0.702	1.	1	43	30	42.57	....	Inert matter, broken seeds.
117	Sweet Mountain, Gregory	0.659	0.3	5	56	22	55.83	12	Flesh of pepper.
129	Bull Nose, Burpee	0.6205	0.5	3	20	38	19.9	....	" "
144	Ruby King, Childs	0.609	0.0	2	57	19	57.	11	None.
159	Large Bell, Maule	0.617	0.4	16	74	15	73.7	7	Broken seeds.
173	Large Bell, Ferry	0.667	0.2	8	54	23	53.89	13	Flesh of pepper.
189	Sweet Mountain, Tucker	0.6965	0.2	1	79	6	78.84	8	" "
202	Sweet Mountain, Lyman	0.661	3.6	3	26	40	25.06	....	" "
212	Sweet Mountain, Willard	0.6595	1.	1	7	9	6.93		Inert matter.
218	Sweet Mountain, Barnett	0.665	0.2	5	60	11	59.8	10	Broken seeds.
230	Sweet Mountain, Rice	0.671	0.0	12	48	10	48.		None.
234	Sweet Mountain, Bray	0.691	0.9	10	76	5	75.31	7	Flesh of pepper.
248	Sweet Mountain, Barrett	0.695	1.8	4	26	11	25.53	....	Broken seed.
261	Sweet Mountain, Halliday	0.656	1.54	10	64	9	63.01	8	Inert matter.
274	Bull Nose, Munroe	0.839	0.4	50	66	0	65.73	4	"
296	Sweet Mountain, Potter	0.7225	2.78	3	56	4	54.44	8	Broken seeds.

Station number.	RADISH.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
59	Early French Breakfast, Dreer	0.933	0.25	97	98	0	97.75	1	Inert matter.
77	French Breakfast, Sharpe	0.792	0.57	100	100	0	99.43	1	Foreign seeds.
88	Beckert's Chartier, Henderson	0.955	2.2	74	84	0	82.15	2	Inert matter.
100	Beckert's Chartier, Weaver	0.8635	1.	98	98	0	97.02	2	"
114	Beckert's Chartier, Gregory	1.012	2.4	95	100	0	97.6	1	Broken seeds.
140	Beckert's Chartier, Burpee	1.116	2.36	74	81	0	79.09	3	Inert matter.
148	French Breakfast, Childs	1.86	0.5	99	99	0	98.5	1	Broken seeds.
166	Chartier's, Maule	0.9635	1.1	99	99	0	97.91	1	Inert matter.
181	Improved Chartier, Ferry	1.117	0.7	99	100	0	99.3	1	Foreign seeds.
184	French Breakfast, Tucker	1.003	1.	87	88	0	87.12	1	"
196	Long Scarlet, Lyman	1.263	0.3	36	41	0	40.87	....	Broken seeds.
225	Improved Chartier, Rice	0.933	5.	43	59	0	56.05	6	"
231	Chartier, Bray	1.053	0.5	63	82	0	81.59	2	Inert matter.
255	Chartier, Barrett	1.0075	1.25	17	29	0	28.63	....	"
260	Chartier, Halliday	0.9785	3.53	64	69	3	66.56	3	"
273	French Breakfast, Munroe	0.9425	2.1	71	73	0	71.46	3	Broken seeds.
295	Chartier, Potter	1.085	0 1	89	91	0	89.09	2	Inert matter.

Station number.	TOMATO.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
68	Dwarf Champion, Dreer	0.275	0.25	89	92	0	91.77	2	Flesh of tomato.
79	Dwarf Champion, Sharpe	0.352	0.5	80	97	0	96.51	4	" "
90	Dwarf Champion, Henderson	0.365	1.	76	98	0	97.02	3	Inert matter.
111	Dwarf Champion, Weaver	0.257	0.1	74	85	3	84.91	3	Flesh of tomato.
119	Dwarf Champion, Gregory	0.231	0.	89	97	0	97.	3	None.
131	Dwarf Champion, Burpee	0.267	0.3	99	100	0	99.7	3	Flesh of tomato.
143	Ignotum, Childs.	0.276	1.4	78	94	0	92.68	3	" "
156	Dwarf Champion, Maule	0.28	0.	91	93	0	93.	3	None.
169	Dwarf Champion, Ferry	0.339	0.2	88	93	0	92.81	3	Inert matter.
204	Triumph Acme, Lyman.	0.2755	0.2	58	70	3	69.86	3	Flesh of tomato.
232	Dwarf Champion, Bray.	0.254	0.1	89	98	0	97.9	3	" "
249	Dwarf Champion, Barrett	0.2895	0.7	91	97	0	96.32	3	" "
265	Dwarf Champion, Halliday.	0.2575	3.7	91	95	0	91.48	3	Inert matter.
280	Dwarf Champion, Munroe	0.2595	1.35	93	96	0	94.7	3	Flesh of tomato.
284	Dwarf Champion, Potter	0.317	1.6	85	92	0	90.53	3	Inert matter.

Station number.	TURNIP.	Weight of 100 seeds in grammes.	Per cent. of impurities by weight.	Per cent. of seed germinated at end of 4th day.	Per cent. of seed germinated at end of 14th day.	Number of hard seeds remaining.	Valuation, per cent.	One-half of sample sprouted in days.	NATURE OF IMPURITIES.
67	Purple Top Strap Leaf, Dreer	0.167	0.0	99	99	0	99.	1	None.
76	Purple Top Strap Leaf, Sharpe	0.184	0.2	95	99	0	98.8	2	Broken seeds.
92	Red Top Strap Leaf, Henderson	0.187	0.5	99	99	0	98.5	1	"
108	Purple Top Strap Leaf, Weaver	0.161	0.0	99	99	0	99.	1	None.
121	American Red Top, Gregory	0.1775	0.4	99	99	0	98.6	1	Broken seeds.
133	Red Top Strap Leaf, Burpee	0.192	0.6	99	100	0	99.4	1	"
151	Purple Top White Globe, Childs	0.2292	0.5	91	94	0	93.53	1	"
165	Purple Top Ruta Baga, Maule	0.3	0.5	61	66	21	65.67	3	"
180	Purple Top Strap Leaf, Ferry	0.192	0.7	97	97	0	96.32	1	Inert matter.
183	White Rock, Tucker	0.263	0.7	69	89	6	88.37	3	"
194	Red Top Strap Leaf, Lyman	0.1535	0.2	98	98	0	97.8	1	Broken seeds.
209	Red Top Strap Leaf, Willard	0.2115	0.6	94	95	0	94.43	1	"
215	Red Top Strap Leaf, Barnett	0.194	0.3	88	92	0	91.72	2	"
226	Red Top Strap Leaf, Rice	0.1825	0.5	69	76	6	75.62	3	Inert matter.
238	Red Top Strap Leaf, Bray	0.211	1.5	100	100	0	98.5	1	Broken seeds.
247	Purple Top, Barrett	0.146	0.7	99	99	0	98.3	1	Inert matter.
266	Purple Top Strap Leaf, Halliday	0.147	0.2	99	99	0	98.8	1	"
278	Purple Top Strap Leaf, Munroe	0.193	0.0	100	100	0	100.	1	None.
293	Purple Top Strap Leaf, Potter	0.1645	0.5	97	97	0	96.51	1	Inert matter.

REVIEW OF THE DATA IN THE FOREGOING TABLES.

BEET. (SEEDS IN POD.)

The proposed laboratory standard for good merchantable beet seed is

*Vitality 133 per cent.** *Purity 97.5 per cent.*

Nineteen samples of this seed were subjected to the vitality test and not one of them proved to be as good as that proposed in the standard, and some of them were evidently unfit for planting unless it was known that their power of germination was low. The average vitality of the nineteen samples as shown by the tests was 105.6 per cent. It should be stated in connection with this that beet seed is particularly difficult to examine on account of the fact that it is sold without separating it from the short appressed pods, two, three, or more of which are usually formed together and constitute a small ball. These balls are known as beet seed in the market, and they were counted as such in taking the samples for the germination test although it was understood that some of the balls contained more than one seed and that perhaps some of them did not contain any. The tests showed an average of more than one sprout from each ball; the largest number of sprouts produced by any 100 balls being 132. The proposed standard of vitality appears from the test to be slightly too high for this kind of seed as it is at present sold in Rhode Island

The following diagram shows the results of germination tests of nineteen samples of beet seed. The heavy line at the top represents a sample with 133 per cent. Vitality. The other lines represent the proportional vitality of the samples tested.

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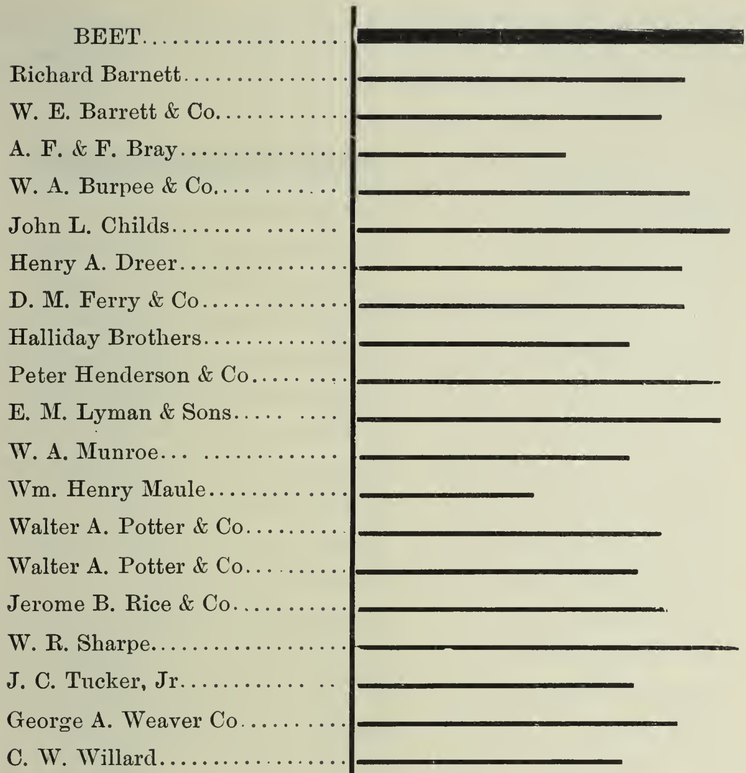
*133 per cent. in this case represents the number of sprouts that 100 good beet seed balls should produce.



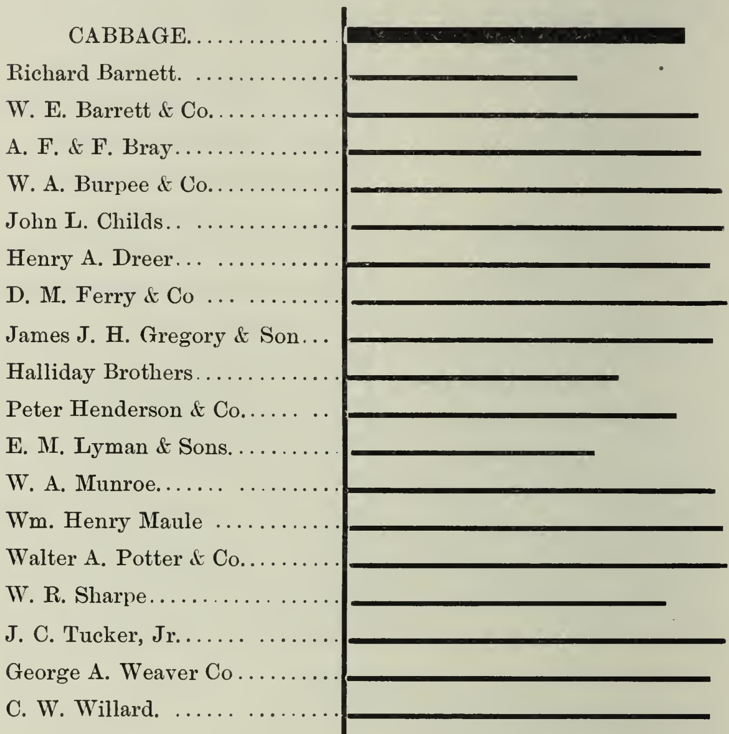
CABBAGE.

The proposed laboratory standard for good merchantable cabbage seed is

Vitality 89 per cent. Purity 99 per cent.

Eighteen samples of this seed were examined and from the data obtained it appears that the proposed standard of vitality and purity is about right. The average vitality of the eighteen samples as shown by the tests was 89.36 per cent., and the average purity was 99.79 per cent. Both of the averages were slightly higher than that in the proposed standard. As a whole the quality of this seed was good, but a few samples of it were poor, and doubtless some purchasers who were unfortunate in securing their supply of seeds from these lots were disappointed in their crops for this reason.

The following diagram shows the results of germination tests of eighteen samples of cabbage seed. The heavy line represents a sample with 89 per cent. of vitality.



CARROT.

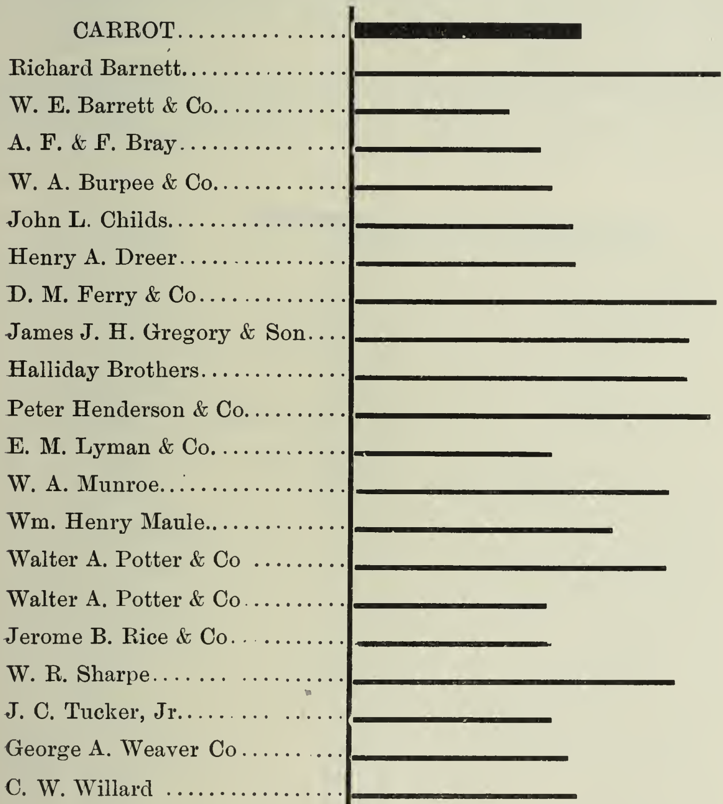
The proposed laboratory standard for good merchantable carrot seed is

Vitality 59 per cent. Purity 90.5 per cent.

This seed was characterized by being of particularly variable quality. The impurities found in the different samples ranged from less than 1 to more than 16 per cent. Eight of the samples produced more than eighty sprouts per hundred seeds, while ten other samples produced less than sixty sprouts from the same number of seeds. From the following diagram it can readily be

seen that no gardener can plant seed of such variable quality with any assurance of obtaining a definite and uniform growth of plants. Seeds that are destitute of vitality cannot grow, and if too many good seeds are sown there is no law that will prevent the surplus from growing if the conditions are favorable.

The following diagram shows the results of germination tests of nineteen samples of carrot seed. The heavy line represents a sample with 59. per cent of vitality.



CELERY.

The proposed laboratory standard for good merchantable celery seed is

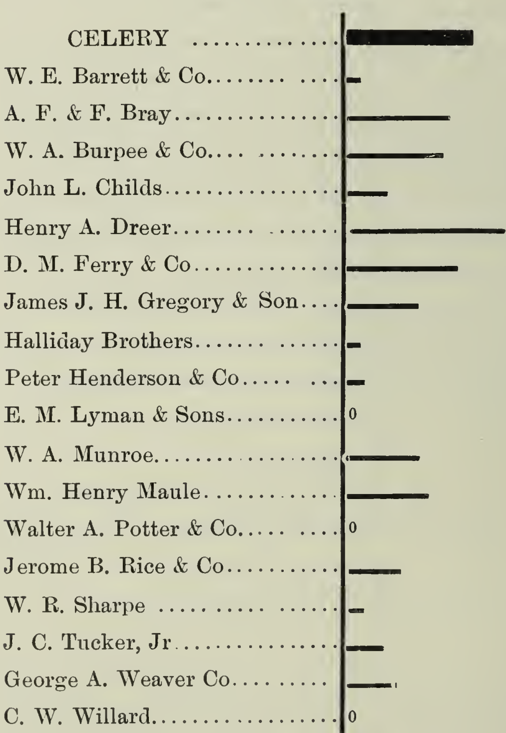
Vitality 32 per cent. Purity 99 per cent.

The vitality of this seed averaged much lower than that of any

other kind tested. There was only one sample that produced more than 32 sprouts per hundred seeds. Three samples produced no sprouts and two others only two sprouts each.

Celery seed is very small. According to the average weight of the seed in the eighteen samples examined there would be in an ounce 62,307 seeds. Yet seedsmen* advise planters to sow an ounce of celery seed for two thousand or twenty-five hundred plants, or 100 seeds for each 3 or 4 plants wanted. The average vitality of the eighteen samples as shown by the tests was 12.4 per cent. This seems low, but the vitality of celery seed is probably exceedingly variable.

The following diagram shows the results of germination tests of eighteen samples of celery seed. The heavy line represents a sample with 32 per cent. vitality.



*Peter Henderson & Co., Seed catalogue, 1895, 1 oz. for 2,000 plants.
W. E. Barrett & Co., " " " " " 2,500 "
Walter A. Potter & Co., " " " " " " "
Henry A. Dreer, " " " " " " "

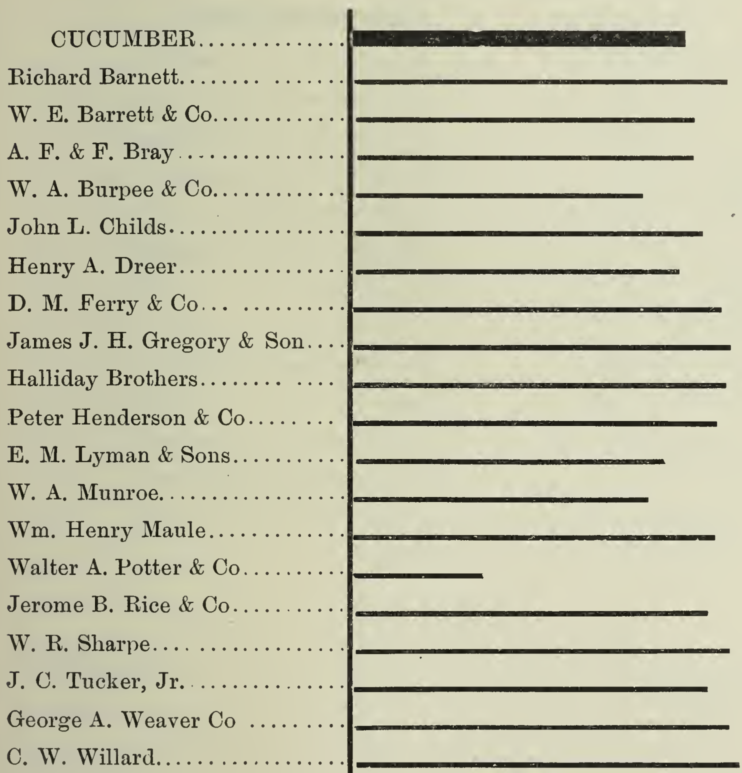
CUCUMBER.

The proposed laboratory standard for good merchantable cucumber seed is

Vitality 86 per cent. Purity 99 per cent.

With a single exception the samples of this seed examined were good. The average vitality and purity were both slightly higher than is required by the proposed standard which appears to be well chosen in this case.

The following diagram shows the results of germination tests of nineteen samples of cucumber seed. The heavy line represents a sample with 86 per cent. vitality.



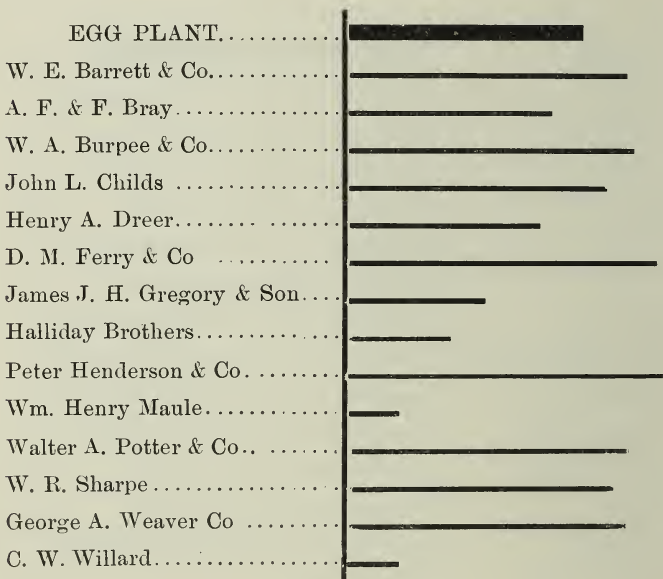
EGG PLANT.

The proposed laboratory standard for good merchantable egg plant seed is

Vitality 60 per cent. *Purity 99 per cent.*

Fourteen samples of this seed were examined and the quality of the different samples was found to be very uneven. The use of seed of such uncertain value for planting purposes does not seem consistent with the aims of modern gardening. The proposed standard of vitality does not in this case appear to be too high, but the vitality of the seed in some lots was not high enough.

The following diagram shows the results of germination tests of fourteen samples of egg plant seed. The heavy line represents a sample with 60 per cent vitality.



LETTUCE.

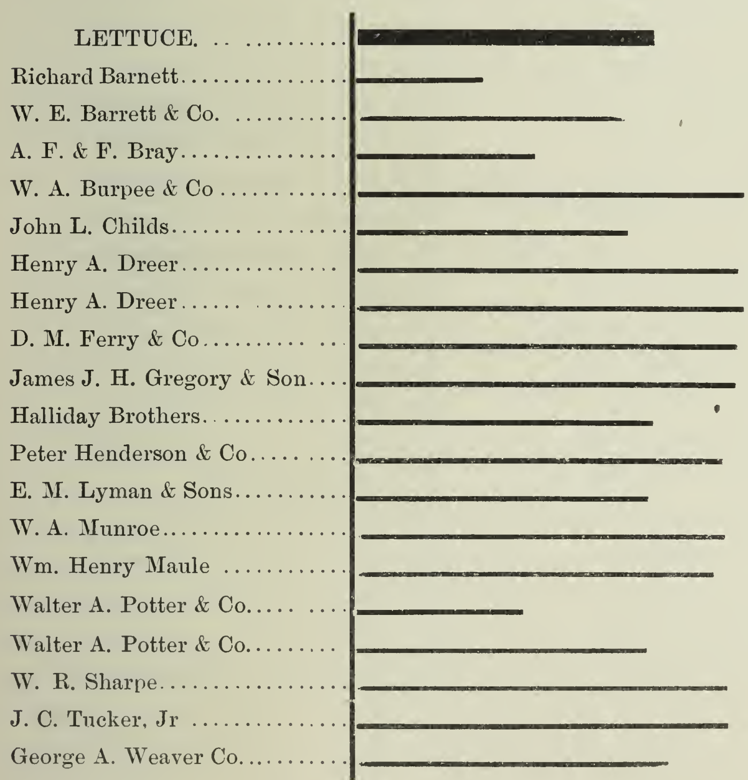
The proposed laboratory standard for good merchantable lettuce seed is

Vitality 77 per cent. *Purity 98 per cent.*

Nineteen samples of this seed were subjected to the vitality test

and ten of them produced 90 or more sprouts per hundred seeds. This suggests that perhaps the proposed standard of vitality could safely be raised at least 10 per cent. It would then be nearly 7 per cent. higher than the average vitality of the nineteen samples examined. But it will be noticed by referring to the preceding table page 145 that three of the samples included showed a vitality of less than 50 per cent., which is evidently much too low for good seed of this kind. If the records of these samples were eliminated from the table the average vitality would be 88.25 per cent., or $11\frac{1}{4}$ per cent. higher than that required by the proposed standard.

The following diagram shows the results of germination tests of nineteen samples of lettuce seed. The heavy line represents a sample with 77 per cent. vitality.



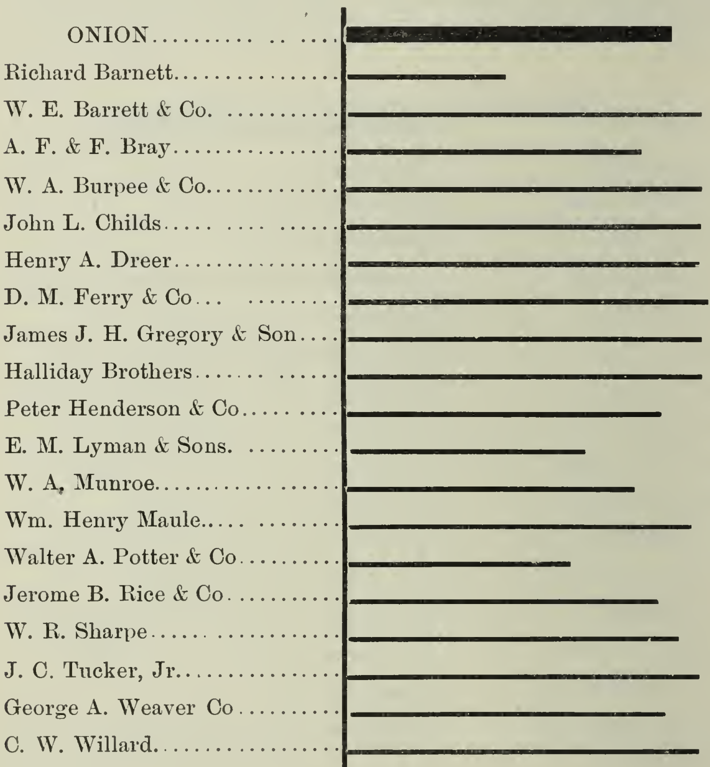
ONION.

The proposed laboratory standard for good merchantable onion seed is

Vitality 85 per cent. Purity 99 per cent.

Nineteen samples of this seed were examined and their relative vitality was found as given below.

The following diagram shows the results of germination tests of nineteen samples of onion seed. The heavy line represents a sample with 85 per cent. vitality.



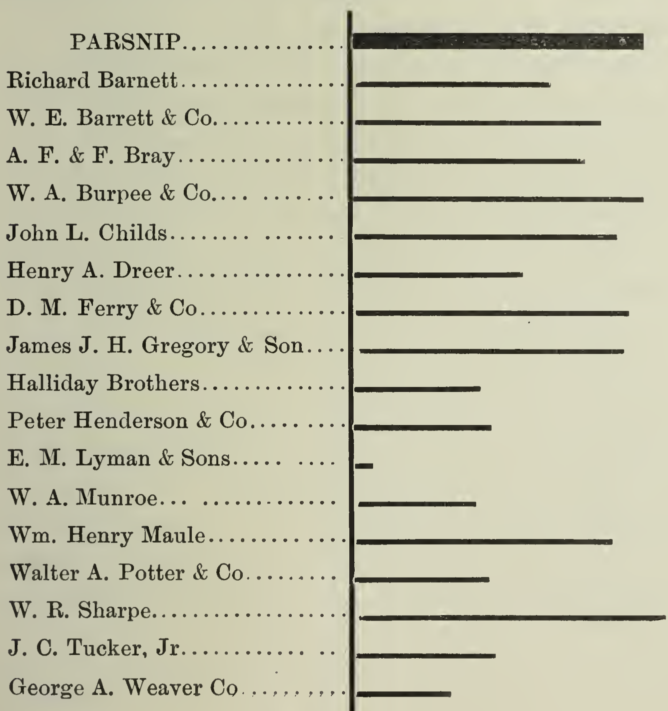
PARSNIP.

The proposed laboratory standard for good merchantable parsnip seed is

Vitality 75 per cent. Purity 99 per cent.

Seventeen samples of this seed were examined and their vitality averaged very low. Only one sample produced more than seventy-five sprouts, and nine samples produced fifty or less sprouts to the hundred seeds. In view of the fact that parsnip plants should be disturbed as little as possible in thinning it would be particularly desirable in this case to know about how many seeds should be sown to the foot, and if the quality of the seed was guaranteed it might then be possible to calculate this with some degree of accuracy. But without knowing whether four, thirty or eighty plants will grow from each hundred seeds that are placed under favorable conditions, the gardener depends much upon chance, and not infrequently he is the loser on account of it.

The following diagram shows the results of germination tests of seventeen samples of parsnip seed. The heavy line represents a sample having 75 per cent. vitality.



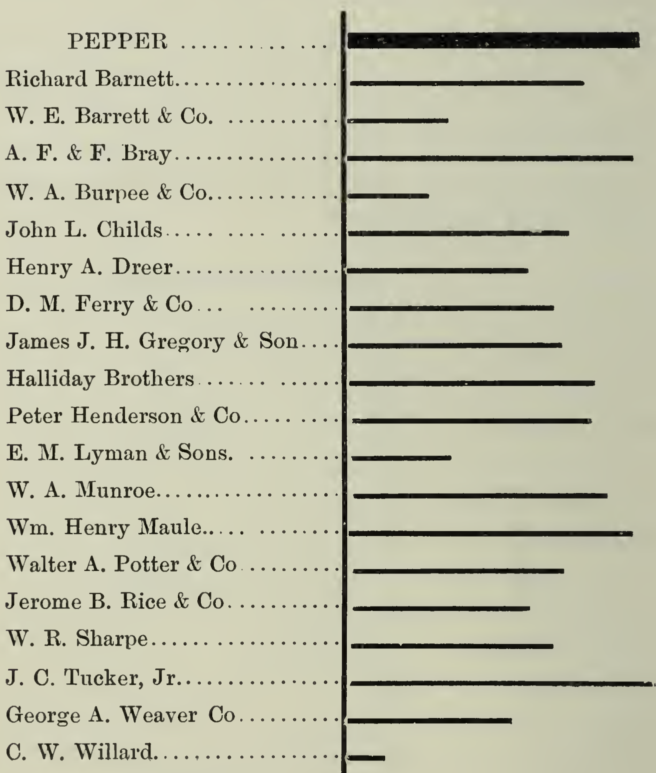
PEPPER.

The proposed laboratory standard for good merchantable pepper seed is

Vitality 76 per cent. Purity 98 per cent.

Nineteen samples of this seed were examined and their uneven value for planting purposes is well illustrated below.

The following diagram shows the results of germination tests of nineteen samples of pepper seed. The heavy line represents a sample with 76 per cent. vitality.



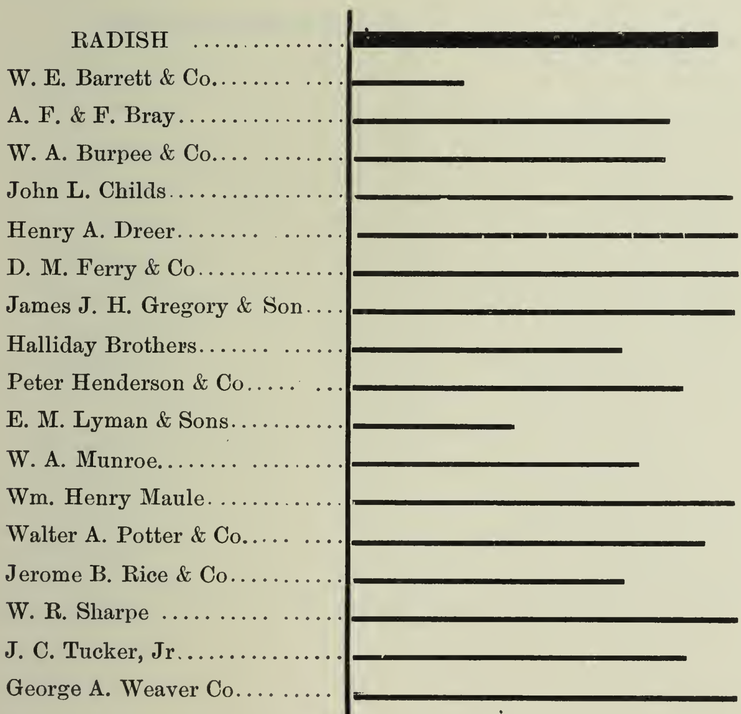
RADISH.

The proposed laboratory standard for good merchantable radish seed is

Vitality 95 per cent. Purity 99 per cent.

Seventeen samples of this seed were examined and in the sprouting tests every seed germinated in three samples, all but one seed in each of two samples, and all but two seeds in each of two other samples. Notwithstanding the good records of these seven samples some of the others were so poor that the average vitality as shown by the test was only 81.8 per cent. or 13.2 below that given in the proposed standard.

The following diagram shows the results of germination tests of seventeen samples of radish seed. The heavy line represents a sample with 95 per cent. vitality.



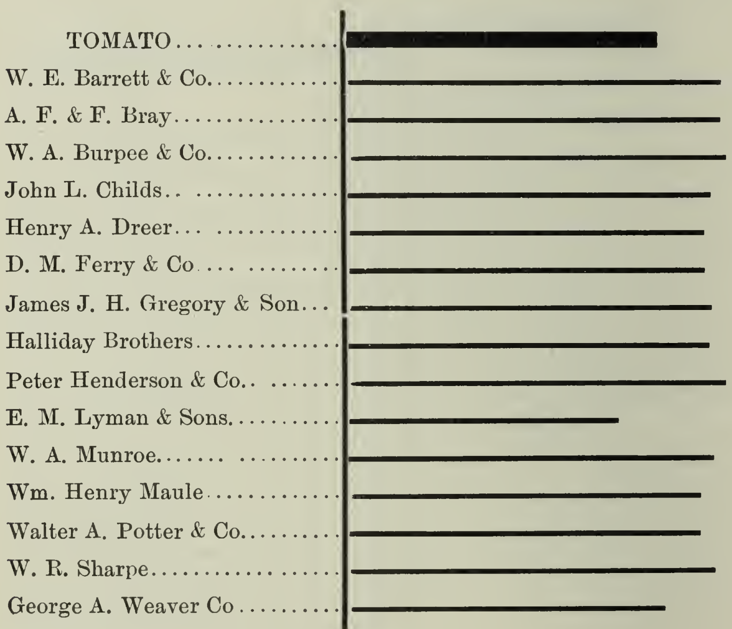
TOMATO.

The proposed laboratory standard for good merchantable tomato seed is

Vitality 80 per cent. Purity 98 per cent.

Fifteen samples of this seed were examined, and with one exception, every sample produced more sprouts during the germination test than is required by the proposed standard which in this case appears from the results of these tests to be at least 10 per cent. lower than necessary.

The following diagram shows the results of germination tests of fifteen samples of tomato seed. The heavy line represents a sample with 80 per cent. vitality.



TURNIP.

The proposed laboratory standard for good merchantable turnip seed is

Vitality 94 per cent. Purity 99 per cent.

These seeds were of more uniform quality than any other samples examined.

The following diagram shows the results of germination tests of nineteen samples of turnip seed. The heavy line represents a sample with 94 per cent. vitality.

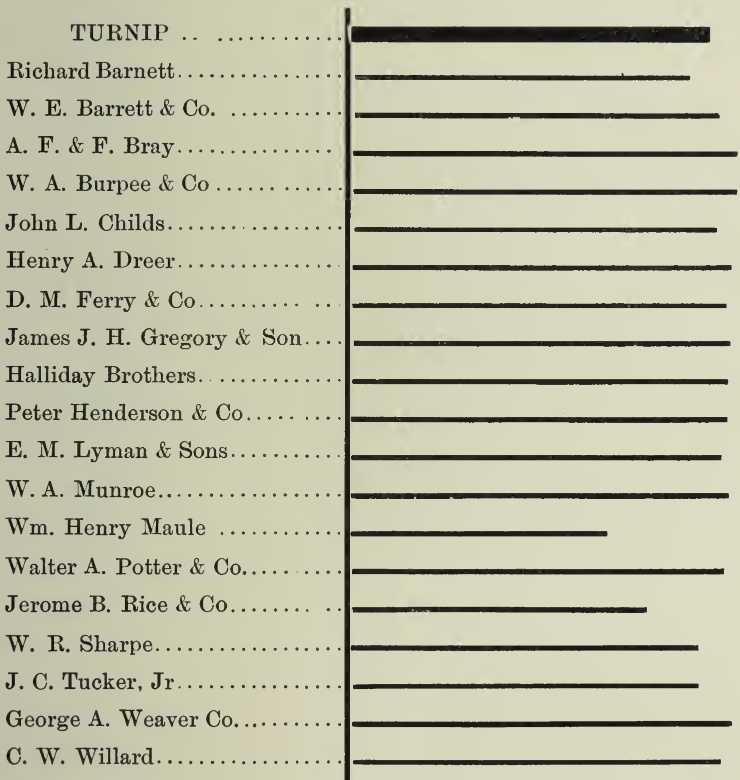


TABLE SHOWING THE AVERAGE VITALITY AND PURITY OF THE SAMPLES TESTED.

				Per cent. Vitality.	Per cent. Purity.
Beet	Average of	19	samples	105 63	98.53
Cabbage	"	18	"	90 22	99.79
Carrot	"	20	"	66.20	94.92
Celery	"	18	"	12 38	98.98
Cucumber	"	19	"	86.63	99 69
Egg Plant	"	14	"	53 07	98.89
Lettuce	"	19	"	80.68	98 43
Onion	"	19	"	82 30	99.76
Parsnip	"	17	"	48.84	98 48
Pepper	"	19	"	51.26	99 05
Radish	"	17	"	81.82	98.54
Tomato	"	15	"	93 13	99.38
Turnip	"	19	"	94 57	99.55

AVERAGE WEIGHT OF 100 SEEDS IN GRAMS.

Beet balls	Average of	19	samples	1.5246
Cabbage seeds	"	18	"	.3957
Carrot "	"	20	"	.1323
Celery "	"	18	"	.0455
Cucumber "	"	19	"	2 5683
Egg Plant "	"	14	"	.4348
Lettuce "	"	19	"	.1242
Onion "	"	19	"	.3542
Parsnip "	"	17	"	.4292
Pepper "	"	19	"	.6718
Radish "	"	17	"	.9898
Tomato "	"	15	"	.2876
Turnip "	"	19	"	.1924

AVERAGE NUMBER OF SEEDS IN AN OUNCE.

(Calculated from the weight of 100 seeds.)

Beet	Average of	19	samples	1,203
Cabbage	"	18	"	7,165
Carrot	"	20	"	21,421
Celery	"	18	"	62,307
Cucumber	"	19	"	1,103
Egg Plant	"	14	"	6,520
Lettuce	"	19	"	22,020
Onion	"	19	"	8,004
Parsnip	"	17	"	6,605
Pepper	"	19	"	4,220
Radish	"	17	"	2,864
Tomato	"	15	"	9,857
Turnip	"	19	"	14,734

SUMMARY.

1. The quality of garden seeds depends—
   - (*a*) Upon their freedom from impurities.
   - (*b*) Upon their vitality, or power of germination.
   - (*c*) Upon their being true to name.

2. In the samples of seeds collected there was very little foreign matter. This is shown on page 134. More might have been found if other small agricultural seeds had been included in the investigation.

3. Many samples contained a large per cent of dead seeds. In twenty of the samples three-fourths of the seeds were useless for planting purposes, and in twenty-three other samples one-half or more of the seeds failed to produce sprouts during the germination tests. On the other hand, in sixty-four samples only 5 per cent. or less of dead seed was found.

4. Buying garden seeds without knowing whether they are dead or alive is a good deal like buying a pig in a bag.

5. No tests were made to find out whether the seeds were correctly named or not, although this is a matter of much importance to planters.

6. The dealer does not place himself under any obligations to the purchaser by printing TESTED SEEDS in large type at the top of all his seed envelopes when he puts lower down and in less conspicuous type the following familiar paragraph :

"While we exercise the greatest care to have all seeds pure and reliable, we do not give any warranty expressed or implied. If the purchaser does not accept the seeds on these terms and conditions, they must be returned at once and the money that has been paid for them will be refunded."

7. The seeds obtained from some dealers average better than those that were obtained from others, but while no guarantee of the quality is either expressed or implied, carelessness on the part of the dealers is likely to continue to cause those who plant seeds a great deal of trouble.

8. The results of labaratory tests of the vitality of seeds may be nearly uniform. Two hundred and thirty-three of these tests were made in duplicate, and in only twenty-one cases was there a variation of 5 per cent. in the number of sprouts produced by the two lots of seed taken from the same sample.

9. No standards of vitality and purity for garden seeds have yet been adopted by those engaged in testing seeds in this country. Those given in this bulletin have been used for convenience in our work. See foot note, page 138.

April 29/1896.

Bulletin 36. January, 1896.

KINGSTON, RHODE ISLAND.

POTATO CULTURE.

HASTENING MATURITY.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 36.

A TEST OF NORTHERN AND HOME GROWN SEED POTATOES.

CHAS. O. FLAGG, J. D. TOWAR, AND GEO. M. TUCKER.

It is a common practice with potato growers to plant only northern grown seed tubers, although the cost of the same is generally greater than that of home grown seed. They justify their course by the claim that a larger yield is secured while those who use home grown seed tubers claim that they will produce equally good crops. The following experiment had for its object the comparison of the yield derived from planting seed tubers grown in the north with the yield of those grown in Rhode Island.

Early in 1894, seed tubers of the fourteen varieties named in the following table, were donated by W. S. Sweet & Son of Providence, from their stock of Aroostook Co., (Maine) seed potatoes, in sufficient quantities to plant one row 208 feet long of each variety.

The land selected for the experiment was the easterly end of a field in clover sod which had produced two crops in 1893 and oats in 1892.* The soil is a rather light, sandy loam and was plowed with our Syracuse sulky swivel plow April 16th, and on the following day the soil was thoroughly harrowed and prepared for planting the potatoes. On the 18th fertilizer was applied broadcast and in the drill at the following rates per acre : 65 lbs. of nitrate of soda, 498 lbs. tankage, 367 lbs. dissolved phosphate rock, 78 lbs. fine ground bone and 196 lbs. muriate of potash. Three-fourths of the fertilizer, after a thorough mixing of the ingredients, was applied broadcast and well incorporated with the soil. The other

* See page 193, Sixth Annual Report, page 136, Fifth Annual Report.

fourth was applied in the drill, care being taken to insure an equal distribution in each application.

Each row was planted on the above named date to 10 lbs. of seed cut in 150 pieces, dropped carefully by hand 16 inches apart and covered with a light furrow. During the season the plot was given clean cultivation in the ordinary way with horse cultivator and hand hoe.

Early in July the potato blight began to show itself to a slight degree, and on the 7th the potato vines were sprayed with Bordeaux mixture and also again on the 16th, which two applications checked the disease and the potatoes were left in the ground until thoroughly mature. On September 7th the digging of the tubers began, the weights of both large and small potatoes were carefully taken, (tubers less than 2 oz. in weight were classed as small), and the tubers stored to be used as the home grown "seed" the following season.

The result of the season's crop is tabulated below, in the columns headed 1894.

TABLE 1.

	Large tubers. Yield per acre.		Comparison of yields using S. Beauty as 1.		Condit'n of vines on Aug. 11th.	Condition of vines on Aug. 1st.*		Condition as to blight.†	
	1894.	1895.	1894.	1895.	1894.	1895.		1895.	
	bushels	bushels	N. S.‡	N. S.	N. S.	N. S.	H. S.‡	N. S.	H. S.
Burbank..........	277.33	70.58	2 68	0.43	Green	¼ dead	⅛ dead	2	2
Dakota Red........	267 46	96.83	2 59	0.58	Green	Green	Green	1	1
White Star.....	242.53	88.66	2.35	0.54	Green	Green	¼ dead	3	3
King of the Early...	209 67	97.13	2.03	0.58	½ dead	½ dead	¼ dead	3	3
White Elephant....	208.53	100.33	2.02	0.61	Green	⅛ dead	Green	2	2
Houlton Hebron...	207 40	89.25	2 01	0.54	Green	¼ dead	¼ dead	2	2
Houlton Rose	200.03	34.42	1.94	0.21	½ dead	¼ dead	¼ dead	3	3
Polaris......	179.63	94.50	1.74	0.57	¼ dead	¾ dead	¼ dead	4	3
Early Norther......	168.86	95.38	1 63	0.57	Green	½ dead	¼ dead	3	3
Thorburn.........	155 83	98.00	1.51	0 59	Green	Green	¼ dead	3	3
Early Maine.......	148.75	80.50	1 44	0 48	Green	½ dead	¼ dead	4	4
New Queen.........	146 48	74.66	1.42	0.45	¾ dead	¼ dead	½ dead	3	4
Sunrise............	130.90	101.50	1.26	0.62	¾ dead	¼ dead	¼ dead	3	3
Stray Beauty.......	103.13	164 79	1.00	1.00	½ dead	¾ dead	½ dead	1	1

* Aug. 22 all vines dead.

† 1—Least affected; 2—More affected; 3—Still more affected; 4—Most affected.

‡ N. S.—Northern grown seed. H. S.—Home grown seed.

In the above table the varieties are arranged in the order of total yields in 1894. The large decrease observed in the 1895 column is undoubtedly due to the extreme persistency of the potato blight which so generally affected the potato crop and materially decreased the yield in this State.

Notes upon the growth of the varieties were taken during both seasons from which the above table was compiled.

The ground for this season's experiment, 1895, was not identical with that of last season, but a plot of sandy loam plain land of rather better quality was selected which had not grown potatoes for a number of years. It was also a clover sod, cutting two crops in 1894, oats in 1893 and carrots in 1892 and 1891. Plowing was done April 26th. The same quantity of chemical fertilizer per acre was applied this year as last, that is: nitrate of soda, 65 lbs.; tankage, 498 lbs.; dissolved phosphate rock, 367 lbs.; fine ground bone, 78 lbs.; and muriate of potash, 196 lbs. Three-fourths of the quantity was applied broadcast and harrowed in before planting. The other fourth was put into the furrow and mixed well with soil before the potatoes were dropped on May 7th. The home grown seed was a portion of the crop raised last season as above stated and the northern grown seed tubers were donated, as last season, by Messrs. W. S. Sweet & Son from their stock of Aroostook Co. seed potatoes. Each ten pounds of seed tubers was cut into two-eye sets and dropped 16 inches apart in the drill. The seed tubers were covered with a "Planet Jr." cultivator, which had the double mouldboard tooth attached to the rear, thus covering from both sides of the furrow. As the season was about two weeks later than usual and the soil cold in consequence, the plants were very late in appearing above ground, but before they came up and on the 25th of May, a bush or brush harrow with a heavy head was drawn diagonally over the piece, which produced a nearly level field on which to begin cultivation, and at the same time killed all of the weeds which had started to grow.

Just as the potato plants began to appear above the surface of the ground a "Breed's Weeder" was freely used to good advantage. The potato plants then received the usual attention with the horse cultivator and the hand hoe. Paris green was applied twice during the month of June by the use of an "Excelsior Powder Duster," while on July 17th the vines were sprayed with Bordeaux mixture.

That a better estimate of the power of each variety to resist the

potato blight might be obtained, only one application of Bordeaux mixture was made. A sufficient quantity, however, was applied to insure a fair crop from which to make comparisons, and yet some estimate could be drawn as to the working of the disease on the several varieties. The mixture was put on by the use of a wheel-barrow sprayer and care was taken to insure practically an equal amount upon each row. The tubers were dug Aug. 21st and weighed, large and small separately. The results were not altogether gratifying, although a majority of the varieties produced a larger yield from the northern grown seed.

The conclusions to be drawn from the results of that portion of the experiment which was conducted in 1895 will have special bearing upon the relation to each other of the quantities of merchantable tubers raised from the northern and home grown seed of each variety used. From the fourteen cases, as indicated in the columns headed "per cent. of merchantable tubers," it is observed that eleven of them favor the northern grown seed, while two show a gain in favor of the home grown seed, and one shows no difference whatever. Therefore if the total yields per acre, of the northern and home grown seed, can be relied upon as being equal in all cases, there certainly would be no hesitation in stating that there is a decided advantage in planting the northern grown seed, for the quantity of merchantable tubers, which is the basis of the crop value, will be greater under such circumstances. But as seen by the total yield columns such is not the case; for these yields are not equal in the case of any variety, but the first seven varieties gave a *greater* total yield with the northern grown seed. Therefore, not only did these varieties produce a greater yield of merchantable potatoes from the very fact that the total yield was greater than from the home grown seed, but also the quantity of merchantable potatoes was increased still more because a greater per cent. of this total yield was of merchantable size.

Thus the real comparison of values of the two kinds of seed tubers used in this experiment will be found in the next to the last column, where the varieties are arranged in regular order with that one which gave the greatest increase of merchantable tubers at the head. And here it will be noticed an increase was obtained by the use of northern grown seed in nine cases out of the fourteen. But the average increase per acre of the nine varieties by the use of the northern grown seed was 17.04 bushels, while the average

TABLE 2.

NAME OF VARIETIES.	YIELD IN BUSHELS PER ACRE. 1895. Total. N. S.*	Total. H. S.*	Large. N. S.	Large. H. S.	Small. N. S.	Small. H. S.	No. of two-eye pieces cut from 10 lbs of seed. N. S.	H. S.	Per cent. of merchantable tubers. N. S.	H. S.	Large Tubers. Per cent. of gain (+) or loss (—) of N. S. relative to H. S.	Large Tubers. Bushels of gain (+) or loss (—) of N. S. relative to H. S.
Stray Beauty	200.37	148.75	164.79	105.00	35.58	43.75	142	158	82.24	70.59	+ 36.28	+59 79
Dakota Red	130 37	110.83	96 83	75.25	33.54	35.58	173	159	74.28	67.90	+ 22.32	+ 4.61
Thorburn	118.71	114.63	98.00	78.17	20 71	36 46	216	179	82.55	68.19	+ 20.23	+19.83
Early Norther	132.71	109.08	95.38	77 58	37.33	31.50	177	134	71.87	71.12	+ 18.66	+17.80
Polaris	122.79	112 58	94 50	79.33	28.29	33.25	202	177	76.96	70.46	+ 16.05	+15.17
White Star	124.83	118.42	88.66	78.17	36.17	40.25	213	151	71 02	66.01	+ 11.84	+10.49
Sunrise	142.92	127.46	101.50	90.42	41 42	37 04	152	164	71.02	70 94	+ 10.91	+11.08
White Elephant	124.83	126.58	100.33	91.58	24.50	35.00	156	167	80.37	72.35	+ 8.72	+ 8.75
Burbank	98.58	105.59	70.55	64.76	28.00	40.83	184	198	71 57	61 33	+ 8.24	+ 5.82
Houlton Hebron	123.08	127.75	89.25	90.42	33.83	37.33	160	167	72.49	70.78	— 1.31	— 1.17
Early Maine	121.33	124 83	80.50	82.83	40 83	42.00	228	140	66.35	66.35	— 2 88	— 2.33
New Queen	102.66	129.79	74.67	92.17	28.00	37.62	225	172	72.73	71.01	— 23 45	—17.51
King of the Early	132.13	155.75	97 13	128.33	35 00	27.42	213	188	73.51	82.39	— 32.12	—31.20
Houlton Rose	49.88	119.58	34.42	86.92	15.46	32.56	225	168	69 01	72.70	—152.53	—52.50

* N. S.—Northern grown seed. H. S.—Home grown seed.

increase per acre of the five varieties by the use of the home seed was 20.94 bushels. It is therefore questionable whether the northern grown seed will be of advantage in every case, yet the result of the whole experiment points to the use of the northern grown seed tubers as preferable to that of the home grown.

Bearing upon this subject is a trial of Vermont and Maryland grown seed potatoes at the Experiment Station in each of those States, in which it was shown that the Vermont grown seed tubers gave the greater yield, whether planted in Maryland as "northern grown seed" or in Vermont as "home grown seed."[1]

In Missouri a trial of "home grown" "White Star" tubers with seed tubers of the same variety grown in Vermont and in Wisconsin resulted in a much greater yield from the northern grown seed.[2] These trials indicate that seed tubers grown in the northern States will produce greater crops, other conditions being equal, than tubers of the same varieties grown in more southern localities.

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[1]Md. Annual Report, 1889, p. 56, 1890, p. 108; Vt. Annual Report, 1889, p. 143, 1890, p. 186.

[2]Mo. Bulletin No. 15.

EARLY POTATOES.

CHARLES O. FLAGG AND GEORGE M. TUCKER.

In the growing of farm or market garden crops which find a place daily on the tables of rich and poor alike, the first of the product to reach the market in a reasonably perfect condition often brings a price far beyond the average market rate, or the price a few days later when the supply is fairly adequate to the demand. This stimulates such as have lands favorably located for early cultivation to compete in the growing of early crops, and advantage is taken of southern latitudes and locations where the climate is modified by the influence of large bodies of water to hasten the maturity of crops for northern markets. As a result we have an immense produce growing and shipping industry in the Southern Atlantic States, which supplies our market weeks in advance of the crops grown in our immediate vicinity, and generally to the disadvantage of the northern cultivator in the price realized when his crop is ready for market. Certain localities find their conditions especially favorable to produce certain crops, therefore they receive most attention and become the staple market crops. We find the early potato grown in immense quantities upon the Island of Jersey for the London market, and in Bermuda for the New York and Boston markets. Later the supply for the two latter cities comes from the South Atlantic States, and then from Long Island until the last half of July and August when thousands of bushels of early potatoes are shipped from the Island of Rhode Island and other places in this State to the Boston market. Besides taking advantage of conditions of climate, location and soil, much attention is given to the selection of the best early variety; to early plowing and planting; to thorough cultivation and especially to supplying fertilizers in abundance—far in excess of the demands of the crop—and of such a character as to force the crop to growth and maturity as quickly as possible. In addition to the foregoing, various methods have been pursued for still

further hastening the maturity of the crop, all of which are in the direction of starting the seed tubers into growth before planting.

HASTENING MATURITY. FIRST METHOD.

Private gardeners have long followed the practice of planting tubers in pots and growing them to a few inches in height under glass when, after all danger of frost is past, they are transplanted to the open ground. This course is feasible for a family supply only, as the expense of starting the tubers in sufficient numbers for a market crop would preclude all profit from the operation.

SECOND METHOD.

The second method of hastening the maturity of early potatoes may be called "sprouting" and has been followed by some residents of Rhode Island with excellent success. The following is substantially the method pursued for some years by Hon. E. F. Dyer of Portsmouth, R. I. The requisites for sprouting potatoes are an ordinary cold frame and sash such as are used by gardeners. About twelve sash 3 x 6 feet in size are required for each acre of potatoes. As soon as the ground thaws in the spring, or about four or five weeks before time for planting in the field, the cold frame is prepared. The place selected should have a south or southeast exposure, protected if possible from cold northerly winds by a building or wall. The soil should be thoroughly worked over the previous fall by plowing or digging. In the spring at the time of making the cold frame the soil should not be worked more than three inches deep, at which time some good complete fertilizer at the rate of two quarts for each sash should be applied and thoroughly raked into the earth. The sides of the frame are made of boards or plank 12 inches in width, held in place by stakes driven into the ground. The back or north side of the frame should stand two inches higher than the front or south side, that the sash may have a slope of two or three inches toward the south. The outside of the frame should be banked up with earth, litter or horse manure to keep out frost. Straw mats or shutters may be necessary to cover the sash on especially cold nights. Mr. Dyer uses a division between each two sash, made by fastening a strip of wood two inches thick by one inch wide to a piece of board three inches wide and long enough to reach from

the back to the front of the cold frame. This forms a ledge upon which the sash may slide up or down for ventilation, but the ordinary custom of ventilating hotbeds by raising alternate sash at the top and others at the bottom, more or less according to the weather, would doubtless serve the purpose and render the crossbars unnecessary. The cold frame and soil having been prepared from the 15th to the 20th of March, the seed tubers are put into the bed for sprouting. It is his custom to procure potatoes for seed from some northern latitude, generally Maine. Such seed usually gives strong single vines from each set and produces tubers of good size, while home grown seed is more likely to produce two or more vines from a set and more small potatoes in each hill. These seed tubers he cuts into pieces not smaller in size than an English walnut, each of which contains one or more good eyes. In cutting them the two or three eyes nearest the stem of the potato are rejected, as he has found by experience that they do not start as readily as the other eyes of the tuber and are always considerable later if planted. Three pecks of seed tubers are required for each sash and about twelve sash for each acre planted. After cutting, the sets are placed upon the earth in the cold frame as thickly as they will lie, the skin side upward. They are then covered with fine earth four inches deep. The bed will not require watering as a rule. Some care must be taken in regard to ventilation, and his guide in the matter is the condensation of the moisture upon the under side of the sash. If moisture condenses so as to cloud the glass or stand in drops on the under surface the sash should be opened so as to admit air, more or less, according to the warmth of the sun and the temperature of the atmosphere. He aims to prevent condensation on the under side, as the drip of water from the sash upon the bed is more than likely to cause the sets in that particular spot to decay. If the weather is cold and the spring is likely to be late more air should be given that growth should be slower and the sprouts may not become too far advanced for setting. The best time for setting them in the field is at the time when they are "breaking ground."

The field is prepared much the same as usual except that the furrows after having the fertilizer distributed in them are filled by turning furrows into them with a plow or by the use of a hoe. About 1800 pounds of commercial fertilizer is applied per acre when no other fertilizer is used. It is usually applied in the drill with a machine. When applied by hand a ten quart pailful is used

for each sixty paces of drill, requiring about 1800 pounds per acre. After the furrow is filled with earth a one-horse subsoil plow is run down the centre of each drill. This mixes the fertilizer applied with the earth used in filling the furrow and leaves a narrow open furrow in which to set the sprouted tubers. When all is ready the sets are lifted from their position in the cold frame with a manure fork. Beginning at the end of the bed the fork is inserted under the roots about three inches below the line formed by the pieces of tubers and then lifted, raising the sets out of place and loosening them. They are then taken up by hand, carefully separated and placed in boxes which should be kept covered from the sun and air as far as possible. In this operation the earth practically all separates from the sprouted sets and their roots. The boxes are taken to the field and the sets carefully placed by hand about 12 inches apart in the narrow furrow before mentioned. These furrows are made from 30 to 32 inches apart. It requires about eight men one day to set out the sprouted tubers upon one acre. After the sets are placed in the furrow a hoe is used to draw the earth around the sprouts, which are usually entirely covered with earth, or if all danger of frost is past, left about as they stood in the cold frame, just "breaking ground." Last season, although the blight prevented a full crop from seed tubers cut and planted in the ordinary manner, Mr. Dyer dug on the 10th of August and sold, from three-quarters of an acre, 85 barrels of "Queens" grown by this method. He wishes to state, however, that the average yield of previous years when other varieties have been planted has not reached the yield obtained this year. His average yield has been about 95 barrels per acre.

THIRD METHOD.

The third method may be termed *budding*, and as described in an article by the writer published in the *Cultivator and Country Gentleman*, issue of March 4, 1886, page 166, is a modification of the method in common use in the Island of Jersey and in England. The course pursued there is described on another page of this bulletin in some notes on potato culture by a resident of the Island of Jersey. The seed tubers for this method of hastening the maturity of the crop should be about the size of hen's eggs, and when ready for planting appear as represented in the cut, Fig. 1.

FIG. 1.
Exposed to light and heat in an office in the chemical laboratory about three months.

FIG. 2.
Rack and trays for budding potato tubers.

FIG. 3.
Tray partially filled with seed tubers.

The requisites necessary for budding seed tubers are a moderately warm, light place in a room or basement where the temperature is reasonably uniform, never reaching the freezing point, and sufficient space so that the seed tubers can be exposed in single layers for from four to six weeks to the influence of moderate heat and a fair amount of light. Mr. Coy of Maine, who won the first prize offered by the *American Agriculturist* a few years ago for the largest yield from an acre of potatoes, "budded" all his seed tubers by exposing them on the floor of a warm and light room. His object, however, was to insure a *perfect stand* of potatoes, and by budding the seed tubers all which failed to start vigorous buds could be rejected at planting time. We know of this course being followed by a few who have sufficient room for the purpose, but the amount of space required prohibits most farmers from adopting the method. In order to overcome the objection of space required, and to facilitate the handling of the seed tubers, the writer had constructed a rack and trays like those illustrated in Fig. 2.

The rack illustrated is made of planed pine lumber with the exception of the lathes used for the bottoms of the trays. The uprights are $2\frac{3}{4} \times 1\frac{1}{2}$ inches in size and 6ft. long. The two at each end are united by eight cleats placed on the inside, the top of the bottom one being 9 inches from the floor and the rest 9 inches from the top of one to the top of the next. These cleats are 1 ft. 8 inches long and $1\frac{1}{2} \times \frac{7}{8}$ inches in size fastened to the uprights by screws. The two ends are connected by strips 4 ft. long and $2 \times \frac{7}{8}$ inches in size, dovetailed into the uprights. Two diagonal braces are fastened across the back. This rack holds nine trays, the lower one standing on the floor and the others supported by the cleats on the uprights. One of the trays is shown in the cut. They are 1 ft. 6 inches wide x 3 ft. 9 inches long measured on the outside. The ends and middle bar are $1\frac{1}{2} \times \frac{7}{8}$ inches in size and 1 ft. $5\frac{1}{2}$ inches long. The sides and bottoms are made of laths nailed securely about half an inch apart. This arrangement secures a pretty uniform distribution of heat, light and air for all the trays. Each tray will hold about one bushel of seed tubers. The original rack and trays used by the writer were made of rough spruce 2 x 3 inch joists; strips of rough boarding for cleats; parts of broken fence pickets 3 inches wide for the ends and middle bars of the trays and laths for the sides and bottoms of the same. The strips forming the side pieces were fastened with screws to the uprights

and when the rack was not in use could be easily taken off and the rack and trays packed away in a small space. The rack and trays being ready we will next consider the process of

BUDDING.

As before mentioned, the most desirable seed tubers for budding are those about the size of hen's eggs, sound and not mutilated in digging. They may be reserved for the purpose when digging the previous crop and if allowed to become "greened" by exposure to sunlight so much the better, or they may be selected from the bin at any time. During stormy days or at any convenient time during the winter these seed tubers can be placed in the trays and then stacked up anywhere in the cellar secure from rats and frost until wanted. The process of filling the trays is illustrated by Fig. 3. The tray to be filled is placed upon a table or bench and one end elevated about a foot by placing a box or measure under it. Then beginning at the lower side the potatoes selected as above are packed into the rack *stem end down as closely as possible one* layer deep. Tubers cut or pierced by the tines of a potato digger or fork should *not* be used as they are likely to produce sickly or inferior buds.

About six or eight weeks before planting time the rack should be placed in a *warm* and *light* place where there is no danger of frost or damage from rats or mice, and the trays placed in the rack. If the temperature is moderate—60° to 75°—and a fair amount of light reaches all parts of each tray no further attention is necessary ; they *do not* require watering. After a few days tiny white points will be seen at the "eyes" of the tubers, and a few days later it will be noticed that one and often two buds on each tuber will have made more growth than the others. These buds are far different from the white, watery "sprouts" of potatoes kept in a dark cellar. They are thick, firm and tough. If conditions are right, at the end of six weeks they will be from half an inch to an inch in length, and one-fourth to three-eighths of an inch in diameter, with many rudimentary roots at the base waiting for the moment when contact with mother earth shall enable them to burst forth and go about their work of gathering plant food. At the top of the bud are tiny rudimentary leaves also waiting to do their appointed work as soon as opportunity is offered. It is well to look at the trays each day, as, if the rack stands

against a wall, it may be found that the buds at the back side of some of the trays where there is insufficient light have a tendency to grow long and white. In that case move the rack out from the wall and change the trays about so as to reverse their position. In such a case *more light* is what is required. If the buds are not developing rapidly enough give more heat, and if growing too fast or storms and frosts prolong the planting season beyond the usual time, give less or no heat and plenty of light. When budded ready for planting they may be held without injury for days or even weeks by keeping the racks in a *cool, light place.*

PLANTING.

The preparation of the soil does not differ from the course usually followed in growing early potatoes. It should be deeply plowed, made mellow and filled with soluble plant food. For marking out the field a small plow or some implement making an open furrow about six inches deep should be used. Some fertilizer should be thoroughly mixed with the soil at the bottom of the furrow which process will fill it up one or two inches. We are now ready to put in the tubers. The trays should be taken from the rack and carried to the field in a *spring* wagon so as not to break the buds by rough jolting. At the field the most convenient way is to place a rack on a wheel-barrow and run it along between the rows. Two persons can work together at setting the tubers, one on each side of the barrow. Each should be provided with a thin-bladed knife and when a tuber has two good buds it is divided as equally as possible without injury to the buds and the pieces immediately and carefully placed in the bottom of the furrow, the buds pointing upward. When there is only a single well-developed bud the tuber is planted whole. Earth to cover them is drawn into the furrow with a hand hoe. If the weather is cold and frost is likely to appear, cover them evenly with about two inches of earth, but if the weather is mild and all danger of frost is past the tips of the buds may be left at the surface, when in a few days they will make quite a leaf growth. Potatoes may be protected from frost at any time by simply covering them with fine earth. Some years ago in a Southern State we saw two acres averaging three or four inches in height saved from destruction by frost in the following way: A light furrow was turned directly upon the vines of each row covering them entirely from sight.

Next morning the ground was white with frost and potato vines unprotected were killed. During the day the temperature rose and the vines were quickly uncovered by the "help," using the hands only. Very few vines were broken, and the whole operation was the equivalent of one hoeing.

EXPERIMENT WITH SEED TUBERS BUDDED AND NOT BUDDED.

In order to obtain some data in regard to the earliness and yield of budded seed tubers as compared with those planted directly from the cellar and in a dormant condition, the following experiment was made. On March 20th two bushels of Early Rose potatoes rather below medium grade in size—averaging about three ounces each—were selected from the bin and counted so that one should be the counterpart of the other in number, size and quality as far as possible. Each bushel contained 311 tubers. One of the two bushels was placed in a bag and kept in a cold cellar where the tubers remained dormant until planted. The other bushel was placed in a tray as before described and kept in a rack for budding. The rack was placed in the cellar of the Chemical Laboratory which is fairly well lighted and warmed by the hot water heater used for heating the building. The potatoes required little attention until planting time.

Plot No. 36 was plowed on April 30th and prepared for planting. The soil is a light, sandy loam about six inches deep, and had produced potatoes the previous season. The same home-mixed fertilizer was used as in the other potato experiments and in the same way, viz.: 65 lbs. of nitrate of soda, 498 lbs. of tankage, 367 lbs. of dissolved phosphate rock, 78 lbs. of fine ground bone and 196 lbs. of muriate of potash per acre, three-fourths of the quantity applied broadcast and the remaining fourth scattered in the drill and well worked into the soil in both cases. Care was taken that a uniform application was made in broadcasting the fertilizer, and that equal quantities were placed in all the drills.

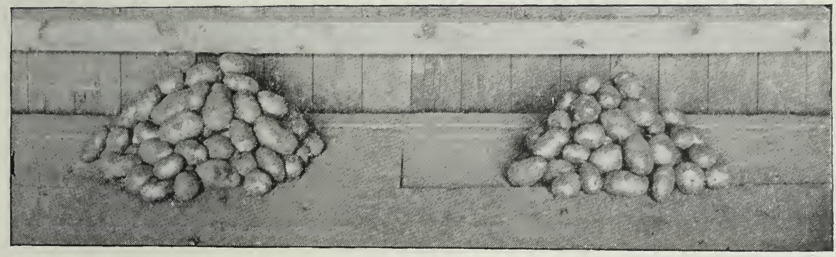
May 1st the potatoes were planted in eight rows—four rows of each—the sets placed fifteen inches apart in the drill. Each tuber was cut once making 622 sets of the budded tubers and the same number of those not budded. Earth was drawn into the furrows with a hand hoe, covering all the sets from one to one and a half inches deep. Before the tubers not budded began to "break

Four rows budded sets. FIG. 4. Four rows dormant sets.

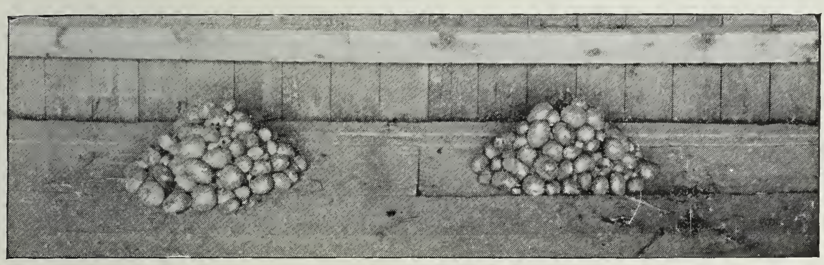
Photographed June 7, 1895, thirty-seven days after planting.

Four rows budded sets. Fig. 5. Four rows dormant sets.

Photographed June 26, 1895, fifty-six days after planting.

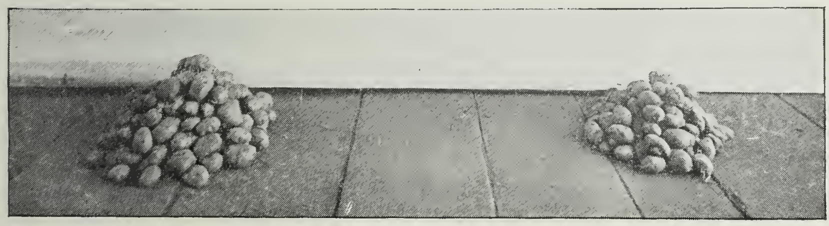


From budded sets. FIG. 6. From dormant sets.
Large tubers. 89 days after planting.



From budded sets. FIG. 7. From dormant sets.
Small tubers. 89 days after planting.

From budded sets. FIG. 8. From dormant sets.
Large tubers. 111 days after planting.



From budded sets. FIG. 9. From dormant sets.
Small tubers. 111 days after planting.

Large tubers. Fig. 10. Small tubers.
From budded sets. 89 days after planting.

Large tubers. Fig. 11. Small tubers.
From dormant sets. 89 days after planting.

Large tubers. Fig. 12. Small tubers.
From budded sets. 111 days after planting.

Large tubers. Fig. 13. Small tubers.
From dormant sets. 111 days after planting.

ground" the budded sets had developed leaves so that the rows could be plainly seen.

The cultivation and treatment given was the same in the case of both lots. On May 11th a "bush" or "brush-harrow" was used on the plot to destroy any weeds just germinating. On May 16th the surface of the ground was lightly stirred with a "Breed's Weeder." June 6th and 29th a cultivator was used between the rows and the potatoes were kept free from weeds by the use of a hand hoe. To protect the vines from the attack of the potato beetle dry Paris green was applied to them with a "powder gun" June 20th and 29th. Traces of potato blight having appeared, Bordeaux mixture was applied by spraying on June 17th, at which time a little Paris green was also mixed with the Bordeaux to destroy the last of the "bugs." Photographs of the plot were taken from which the accompanying cuts were made, and which illustrate the difference in appearance of the vines at different dates and the relative difference in the yield of tubers when dug.

Fig. 4 is from a photograph taken June 7th and illustrates the growth of vines made in 37 days from the time of planting. The vines of the budded sets are seen upon the left side of the cut.

Fig. 5 is from a photograph taken June 26th, 56 days after planting, and shows the relative growth of tops at that date.

Figs. 6 and 7 show the yields of large and small tubers dug from a space 10 ft. wide across the rows of each lot, making the equivalent of 40 ft. of single row of the budded sets and the same of dormant sets. These were dug on July 29th, 89 days from the date of planting. The vines of the budded sets at this time showed signs of maturity by a change of color, while those not budded were still growing. One-half of each lot was dug at this time. The other half of the crop was dug on Aug. 20th, or 111 days after planting, and Figs. 8 and 9 show the crop dug then, from an area equal to that represented by the crop in Figs. 6 and 7.

Figs. 10 and 11 represent the relative yields of large and small tubers from the budded and dormant sets as they were dug on July 29th—89 days from planting—and Figs. 12 and 13 represent the relative yields of large and small tubers from the budded and dormant sets as they were dug on Aug. 20th—111 days from planting. As will be noticed the piles of large tubers in both cases where the budded sets were used, are much larger, as compared with the piles of small tubers, than those produced from the dormant sets.

TABLE 3.—SHOWING RESULTS OF USING SEED TUBERS BUDDED AND NOT BUDDED.

					Yield Per Acre.			Total Yield.	
	Date harvested.	Large tubers, lbs.	Small tubers, lbs.	Total tubers, lbs.	Large tubers, bush.	Small tubers, bush.	Total tubers, bush.	Gain by budding, bush.	Gain by further growth, bush.
Budded ...	July ~~2d~~ 9 ...	156 40	85.00	241.40	97.96	53.23	151.19	32.31	......
Not budded.	" ...	121.50	68.30	189.80	76 10	42.78	118.88	......	......
Budded	Aug. 20th	194.00	79.50	273 50	135.47	55 51	190.98	54.63	39.79
Not budded.	"	135.25	60.00	195.25	94.45	41 90	136.35	.....	17 47

The weights of the large and small tubers in each lot at each digging are found in the first three columns of the table. The next three give the rate of yield per acre and the last two the gain in bushels per acre of the budded sets over those not budded.

A larger yield at the first digging would naturally be expected from the budded tubers, but it is a noteworthy fact that the increase in the crop was greater in the case of the budded tubers at the date of the second digging also. The reason for this is probably to be found in the effect of the potato blight. The budded sets having an earlier start made a greater and more mature growth of tops before the blight appeared and were not so susceptible to injury from it. Bordeaux mixture was thoroughly applied upon both plots alike, but the more succulent tops of the tubers not budded rendered them less able to withstand the disease. No diseased potatoes were found when the crop was dug.

A little more time is consumed in planting the budded tubers as they require more careful handling in order that the buds shall not be broken off. It is best to take them directly from the trays and place them in position in the furrow, cutting them when necessary. In this experiment each budded tuber was cut once in order that the same quantity of "seed" should be used in the same number of hills as in the case of the dormant seed tubers. In ordinary practice, however, tubers which start but one well-

developed bud are not cut but planted whole; hence rather more "seed" per acre is required for budding than for planting in the ordinary way or "sprouting" in cold frames, but as the "seed" for this purpose is of a size hardly saleable the expense is in reality less. The time required for placing the tubers in the trays is of some value, but less important because the work can be done in stormy weather or at times when regular work would be impossible. The larger yield obtained this season by budding would amply repay the extra work involved by this method of hastening maturity.

EARLY POTATO GROWING ON THE ISLAND OF JERSEY.

The Island of Jersey has attained a world-wide notoriety as the ancestral home of the Jersey Cow. The great number of small farms or "holdings" into which the land is divided has doubtless stimulated that painstaking thoroughness and attention to detail which has made possible the evolution of that wonderful butter producer, and the same cause and enterprise has led to an *intensive* agriculture which is a strong contrast to our so generally *extensive* style of cultivation. Jersey is the largest and most southeasterly of the Channel Islands belonging to Great Britain, and is situated 13 miles west of the coast of France and 35 miles south of Portland Bill, a rocky promontory jutting out several miles toward the south from the coast of England. In form it is an irregular parallelogram, 11 miles long by 5½ miles wide. The climate, like that of all Western Europe, is tempered by warm ocean currents and is still further modified by a general southerly exposure due to its rather singular conformation. On the northern side of the island high cliffs rise abruptly from the water to from 250 to 400 feet, and from this height the land gradually slopes to the water's edge on the southerly shore. The force of cold northerly winds is thus broken, and with a generally fertile soil ideal conditions prevail for the production of early crops. It is here that large quantities of early potatoes are grown for the London market, and a personal correspondent on the island, whose modesty requires the writer to withhold his name from publication, has kindly furnished the following outline of their system of cultivation, in which we may find hints for the improvement of our own methods.

NOTES ON THE CULTURE OF EARLY POTATOES IN JERSEY.

ROTATIONS.

Rotation A for light land :

1. Potatoes, followed by roots or barley as an autumn crop.
2. Wheat or clover.
3. Grass for a varying number of years.

Rotation B for heavy land:

1. Potatoes, followed by roots or barley as an autumn crop.
2. Wheat or potatoes.
3. Clover.
4. Grass for a varying number of years.

Although the above is the basis of cultivation it is not always followed, and in the very light or sandy soils potatoes are grown year after year in succession (in some cases this has been done for 25 years), with other crops in the same year as follows :

Potatoes, (1st crop).
Potatoes, roots or barley (2d crop same season).

PLOWING.

The soil is broken up late in the autumn. Farmyard manure is spread and lightly plowed in. The quantity applied is 12 loads of about 1200 lbs. per vergee*, (about $14\frac{1}{2}$ tons, nearly 5 cords per acre). The soil is then cultivated to a depth of about 15 inches by means of two plows. The "little plow" is drawn by three or four horses and is followed by the "big plow" to which six or eight are attached. The period of plowing is January to March, depending on the earliness of the season and the soil.

PLANTING.

The time of planting depends also upon the above causes. Furrows 3 inches deep are made by a plow or spade. Guano or other fertilizer is spread by hand in the furrow and the tubers are planted. The distance between the tubers is six to nine

* An English acre=$2\frac{1}{4}$ "vergees."

inches, and the distance between the rows is fifteen to eighteen inches.

MANURES.

Farmyard manure is applied as stated above. The artificial fertilizers average, 500 lbs. per vergee (1125 per acre), but from 300 to 800 lbs. per vergee (675 to 1800 lbs. per acre) is applied according to the soil and also to the means and disposition of the farmer. Seaweed is used on sandy soils only and the quantity applied varies. It is spread after the second or autumn crop, and left above ground until shortly before plowing, when it is first lightly turned in to be followed by deep plowing. Apart from the contained potash it is found of much use to keep the sandy soils moist during the spring when the weed has not yet all decomposed. In years of drought these sandy soils yield little or next to nothing, as in 1893. On account of this property to retain moisture, seaweed is not used for potatoes on our "heavy lands," as we call our granitic and schist soils. When the plants are half an inch high the soil is "cultivated" between the rows, and also among the rows if the "cultivation" is done by hand. Later on the soil is earthed up and, if frost is likely to obtain, so as to completely cover the young plants.

YIELD.

The crop is frequently dug before it is ripe to secure higher prices. The average yield of these early crops is from three to four "cabots"* per perch, (180 to 240 bushels per acre). The late crops yield from 6 to 10 cabots per perch, (360 to 600 bushels per acre).

COST OF THE CROP.

This is very difficult to specify as it varies much. The average rent may be taken at £10 ($48.66) an acre, but the manure and labor bills so vary that the actual cost of the crop is almost impossible to tabulate. It would not be far out of the way to fix the average gross cost per acre at from £35 to £40 ($170.31 to $194.64).

* 1 cabot=40 lbs. 40 perches=1 vergee. 2¼ vergees=1 English acre.

RETURNS.

Also difficult to average. In the early season the price paid to the farmer is 15s. per 40 lbs. ($5.47 per bushel). It soon drops in the height of the season and fluctuates at about 2s. 6d. per 40 lbs. (91 cents per bushel), but if the English crop is also early, the price in Jersey may drop to even 9d. per 40 lbs. (27⅓ cents per bushel).

VARIETIES.

Three varieties are planted:

No. 1. Myatts, the best flavored.

No. 2. Royals, the earliest and best cropper in heavy soils.

No. 3. Prince of Wales, the favorite in light soils.

No. 2 is said to be derived from an American variety—the International.

Nos. 2 and 3 are always propagated from native seed, but better results are obtained when the seed for a certain soil is obtained from a different one in the island.

The seed of No. 1 is obtained from England every third or fourth year, but the second year's native seed yields the heaviest crops.

SEED.

Tubers for seed are carefully selected, of medium size and well shaped. After the crop has been lifted this selected seed is left in the field for a few days until the tubers are greenish. They are then placed upright in shallow open "boxes" or cases (size 2 ft. x 1 ft. x 3 in.) The boards forming the bottom do not join, and at the four corners are short uprights or corner-posts extending four to six inches above the sides of the box, so that "stacks" of cases can be made allowing free access of air. The more light and air the better for the production of the short, healthy shoots aimed at. The typical shoot is half an inch long, but in less favorable circumstances (regarding light and air) long, white shoots are produced, which are broken off before the planting season in time for shorter ones to be produced. It is only the farmer who has not suitable storage accommodation who unwillingly permits these long shoots, the removal of which is a source of waste to the seed.

If the planting season is very early and the shoots have not budded sufficiently, their growth is hastened by placing the seed boxes in a warm atmosphere (*e. g.* a stable) for a few days. *The object of having these budded seed tubers is to gain time*—the planted tubers have thus a start at once—for the success of the Jersey potato crop depends upon its being sold before the English crop begins. These boxes are also of great convenience in transporting the seed to the field.

COMMENTS.

The first point to which we wish to call particular attention is the *deep* and *thorough* plowing to which the potato fields are subjected. Care is taken that the soil is turned to the full depth at the ends and in the first furrows by opening a trench with a spade so that *every part* of the field shall give a maximum yield. The manure or seaweed spread on the surface is plowed under only three or four inches deep and later the field is thoroughly plowed with two teams, one following the other in the *same furrow*. The first or "little plow" cuts a rather broad furrow only four or five inches deep and turns it into the previous furrow, the bottom of which is at least fifteen inches below the surface of the field. This furrow-slice from the top is a sort of sandwich, being a layer of manure or seaweed between two thin layers of earth. The "big plow" drawn by six or eight horses immediately follows, turning from the bottom of the first furrow a second furrow at least twelve inches deep and throwing it upon the first. This seems like burying the manure too deep, beyond the reach of air so necessary for rapid nitrification, but it must be remembered that there is no crude soil in this depth of earth; the whole mass is like rich garden soil. One authority says,[1] regarding the preparation of the soil for the potato crop in Jersey: "Some farmers prefer spade digging to the large plow for potatoes. A trench is opened at one end of the field, then with the spade the crust is taken off and thrown into it in seams about eighteen inches wide and four inches thick; over this is spread the manure evenly, then the sub-soil is dug and put on the surface, so that when the sets are planted they are almost on the manure itself. This is considered the best mode to insure a good return, for in the case of plowing with the large

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[1] Journal of the Royal Agricultural Society, Vol. XX, p. 42.

plow the manure is frequently sunk too deep." This deep cultivation has been followed for many years for both potato and parsnip crops and as a matter of course the large quantities of fertilizer applied have rendered the soil fertile to the depth of fifteen or eighteen inches. This mass of mellow soil, like a great sponge, absorbs a large quantity of water and holds it until the rapidly growing potato crop demands it for building up the tubers, of which water forms about three-fourths of the weight. The water in the tubers, however, is only a small part of the water required in the processes of growth, as it is continually being evaporated from the leaves and vines. In the growing of early potatoes *growth must be rapid* and abundant moisture *must be within easy reach* of the rootlets or development will be retarded or stopped altogether if the supply of water is scanty or inaccessible through a shallow, lumpy condition of the soil. We do not as a rule plow deeply and thoroughly enough, or cultivate sufficiently to produce crops as large as the soil is capable of producing. But a word of caution is necessary about deep plowing. The process must be *gradual.* Only about an inch of the crude sub-soil, never before touched by a plow, should be turned up at one time. A soil which has never been plowed more than five inches deep can be rendered quite unproductive for several years by immediately plowing it ten inches deep. The five inches of crude sub-soil thrown up to the surface will require considerable time and cultivation to become aerated and oxidized by the air and made a suitable home for plant growth. If the field is plowed a little deeper each year and cultivation is thorough, there will be a constant improvement in its productive capacity, largely through its ability to better withstand drouth.

Not every man who plows deep, fertilizes liberally and cultivates thoroughly will invariably grow extra large crops of potatoes, but we feel confident in asserting that extra large yields of potatoes will only be grown by those who pay particular attention to the thoroughness of these operations.

The second point we would emphasize is the *very close planting,* six to nine inches apart in the drill and fifteen to eighteen inches between the drills. This makes horse cultivation difficult, and in their mellow soil small hand plows worked by two men are often substituted. Such close planting would hardly be desirable except upon soils as rich, deep and mellow as are those of Jersey.

Hand labor is far more expensive in this country and economy in production requires that if possible all cultivation be by horse power; hence the drills must be made farther apart. Some of our most successful growers plant as close as twelve inches apart in the drill and the drills thirty inches apart, but the majority of our farmers plant fifteen to eighteen inches apart in the drill and the drills thirty-six inches or more apart. This distance is perhaps necessary and will doubtless give better results on *very shallow* and *poorly prepared* soil *scantily fertilized* than closer planting, but on mellow, deep soils containing an average amount of plant food and water, closer planting will give more bushels of tubers where sets of the same average weights are planted.

In a very thorough experiment involving this point, carried out in England by Prof. George Maw in 1864 and 1865,[1] the following conclusions were reached. The drills in which the potatoes were planted were two feet apart. Sets were cut weighing 1 oz., 2 oz., and 4 oz. each, of a number of different varieties. Each size of sets was planted in the drills at distances of twelve inches, nine inches and six inches apart. At the same time 4 oz., 6 oz. and 8 oz. sets of a few varieties were planted in drills at 12 and 15 inches apart respectively. It was found that "in the use of small sets of from 1 oz. to 3 oz. in weight a larger balance over and above the weight of the sets was obtained by planting from 6 to 9 inches apart in the rows than at wider intervals" and "increasing the intervals at which the sets are planted even of the largest size (8 oz. each) in the rows to more than 12 inches diminishes the crop and the wider intervals induce no increase in the weight of the produce of the individual sets."

In the *American Agriculturist* Potato Prize Contest, nineteen acres exceeded in yield 400 bushels each. In fifteen cases the seed tubers were cut to sets of from one to three eyes each; one planted whole potatoes; two cut the seed tubers in halves, while one cut to a given size regardless of eyes. The average space allowed each set was 2.83 square feet of surface; hence if any lesson as to the size of sets and distance of planting is to be drawn from the methods pursued in getting these nineteen crops of over 400 bushels each, it is that sets should average one and a half eyes each and be planted 12 inches apart in the row and the rows 34 inches apart.[2] Experiments conducted by J. C. Arthur at the

[1] Journal of the Royal Agricultural Society, Second Series, Vol. III, p. 552.
[2] Sixth Annual Report R. I. Board of Agriculture, p. 270.

Indiana Station[1] showed conclusively that the weight of the set was more important than the number of eyes; in other words, the larger the set (not exceeding 4½ oz. in weight) the larger the yield of merchantable tubers. The same fact is also shown by the experiment of Prof. Maw before mentioned. One objection which might be urged against too narrow a space between the drills would be the difficulty of passing through while spraying the vines for protection against potato blight.

SUMMARY.

NORTHERN VERSUS HOME GROWN SEED TUBERS.

1. Northern (Maine) grown seed tubers compared with seed tubers of the same varieties home grown, produced a greater *per cent.* of merchantable potatoes in 11 out of 14 varieties.
2. Northern (Maine) grown seed tubers gave a greater yield of merchantable potatoes in 9 out of 14 varieties, the average increase being 17.04 bushels per acre.
3. Home grown seed tubers gave a greater yield of merchantable potatoes in 5 out of 14 varieties, the average increase being 20.94 bushels per acre.

HASTENING MATURITY.

1. When early potatoes are grown for market those offered in the most mature condition as to size and quality bring the best price.
2. Certain localities, through the proximity of large bodies of water and favorable climatic conditions, are especially adapted to the production of an early crop.
3. Maturity may be hastened in three ways: (a) By planting sets in pots in a greenhouse and transplanting to open ground; (b) by "sprouting," that is planting sets thickly in a cold frame, and when ready to "break ground" transplanting them to the field, and (c) by "budding," that is subjecting seed tubers the size of hens' eggs from four to six or more weeks to the action of moderate heat and light so that one or two strong buds of a dark color ready to develop leaves and roots are formed on each tuber while all other buds remain practically dormant.

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[1] Bulletin No. 42, Ind. Experiment Station.

4. Budded seed tubers compared with dormant seed tubers in 89 days from planting gave an increase of 21.86 bushels of merchantable potatoes, and a gain in total yield of 32.31 bushels per acre.

5. Budded seed tubers compared with dormant seed tubers in 111 days from planting gave an increase of 41.02 bushels of merchantable potatoes, and a gain in total yield of 54.63 bushels per acre.

6. The increase in growth in the period between the first and second diggings—July 29th and Aug. 20th—was 39.79 bushels in the case of the budded seed tubers, and 17.47 bushels per acre in the case of the dormant seed tubers.

7. For budding, seed tubers one to three ounces in weight are to be preferred. They may be "greened" by exposure to light, on ground free from vegetation, directly after digging and placed in trays at any convenient time during early winter.

8. Where *large seed tubers* are used, *sprouting* is a better method of hastening maturity than *budding* as the tubers are cut into sets before they are placed in the cold frame and a more even development of sprouts is secured than is possible if *large* tubers are subjected to the budding process.

9. The most successful growers of potatoes plow deeply and thoroughly, and fertilize and cultivate well in order that the soil may be a reservoir of moisture and plant food ready to supply *quickly* every demand of the crop.

10. The deeper, richer, and better prepared the soil, the closer may the sets be planted, but the soil should be like that of a rich garden trenched 18 inches deep when sets are planted as close as 6 x 18 inches.

11. In the experiment by Prof. Maw, planting the largest sized sets at a greater distance than 12 x 24 inches did not increase the average yield of the individual sets.

Bulletin 37. May, 1896.

KINGSTON, RHODE ISLAND.

APPLE CULTURE.

CULTIVATE THE OPEN SPACES.

SEE PAGE 35.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 37.

NOTES ON APPLE CULTURE.

L. F. KINNEY.

INTRODUCTION.

Since the adoption of the spray pump as a means of warfare against the pests of the orchard, apple culture in Rhode Island has received a new impetus and the value of apples as a money crop is again recognized here. Orchards that have been neglected for years are now being pruned and fertilized, and growers are vying with each other in the production of this fruit. Along with this progress in the care of orchards, which is generally making them more productive and consequently more profitable, there has been a corresponding progress in the manner in which the crop is utilized. The market period of the apple has been prolonged, cold storage has been used and the ripening processes retarded to a remarkable degree, so that fresh apples are now sold throughout the entire year. This prolongation of the season has led to an increase in the use of apples for dessert, and thus a market is secured both at home and abroad for apples of superior quality. Less choice fruit has been preserved in one gallon tin cans for cooking purposes and this has proved a convenient way of handling a portion of the crop, although at present but a small part of the canned apples that are consumed in Rhode Island are put up here. Still other apples of inferior varieties have been evaporated and some have been made into jellies, but these enterprises have yet scarcely passed the experimental stage in this State.

At this time apple growers not only need encouragement but they also need words of caution, for there are both right and wrong ways to prune, to cultivate, and to spray. Some methods are equally as sure to result in drawing dollars from the pockets of those who practice them as others are to result in bringing dollars in. In this bulletin the attention of the reader is called to some of the needs of an apple tree when it is considered in its relation to its surroundings, for it is only when a number of favorable conditions exist that an apple tree can yield regular and profitable crops of fruit at the present prices for which apples are sold. Occasionally all of these conditions are happily combined by chance, and an apple tree under these circumstances may continue to bear its five or ten barrels of fruit each successive bearing season for a number of years with comparatively little care; but apple trees which are thus favored are in the minority in this State. More frequently the lot of an apple tree falls where the soil is too poor or too dry or where the top is unable to unfold a sufficiently large number of leaves properly to the sunlight. Here culture is necessary, which aims to modify all conditions that are unfavorable to the production of fruit and to supply all needs of the tree.

APPLE TREES NEED TO BE FED.

The modern apple is the product of a fertile soil and regular crops of large and fair fruit should only be expected from trees that are regularly fed. Because apple trees will exist and occasionally bear a partial crop of fruit if they are utterly neglected, it is too often assumed that they require no care after they are planted; but poorly fed apple trees can only be regarded from the fruit-grower's standpoint as unprofitable possessions.

Plant food may be supplied: (*a*) By top dressing the soil beneath and about the trees with farm yard manure during the winter or spring at the rate of one cord to from four to ten trees, depending somewhat upon their size. Occasionally the application may be omitted and an equal value of wood ashes applied in its place. This is an old and reliable receipt that is now being used by many apple growers whose trees generally appear thrifty and productive.

(*b*) By the use of agricultural chemicals and the more concentrated fertilizers. Less is known at present concerning the specific action of these upon the growth of apple trees, although it is be-

lieved by many growers that they can be used with profit in the apple orchard.

(*c*) By the application of sea-weed, which appears to be a good fertilizer for apple trees.

(*d*) By the growth of nitrogen-gathering crops in the orchard and the application of a small amount of fertilizing materials consisting mainly of potash and phosphoric acid. This plan contemplates the growth of a crop on the unoccupied land in the orchard that will return to the soil more plant food than it takes from it, and in a measure make good the loss which the land sustains by taking off a crop of fruit. Where practicable this appears to be the cheapest method of maintaining the fertility of the soil in an apple orchard, although at present it is but little practiced in this State, except in a modified form where the orchards are pastured.

CRIMSON CLOVER AS A NITROGEN GATHERER.

This is a true clover that makes a rank and rapid growth from seed. It is extensively grown in some States as a crop for green manuring, and it appears to have many desirable qualities for this purpose, but thus far it has not proved hardy in Rhode Island. At the Experiment Station it has now been winter killed three years in succession. Still it may be a valuable catch crop for spring and summer sowing.

FIG. 1.
Crimson clover in quart measure. Fall growth from a square foot of land in a young apple orchard.

Fig. 1 shows the fall growth from a square foot of land in a young apple orchard, where the seed was sown at the rate of 16 lbs. to the acre, August 21st. There were 97 of the crimson clover plants on the square foot, and they weighed, including their roots which were carefully washed, 12 ounces. At this rate the fall growth of a crop of crimson clover would amount to over 16 tons of green matter per acre. That such a quantity of organic matter, evenly scattered over and mixed with the soil, has a value as a fertilizer there can be little

doubt. From a similar area in the same orchard where the ordinary red clover seed was sown, 108 plants were taken which weighed only three ounces, or one-third as much as the others. The crimson clover grows later in the season than the red, and covers the soil much better during the winter. As it forms no sod here, plowing in the spring is unnecessary in the orchard unless the land is to be reseeded to clover or some other crop,—the use of the harrow is sufficient to keep the surface soil mellow.

FIG. 2.

Young crimson clover plant showing the branching habit of the crown.

When crimson clover seed has been sown in the spring at this

FIG. 3.

A well formed Baldwin tree planted about 35 years. This tree with seven others planted at the same time, bore in 1892, according to the statement of Mr. O. H. J. Perry, Jr., of Lincoln, R. I., 110 barrels of picked fruit. The tree is 35 to 40 feet high and the branches spread about 40 feet.

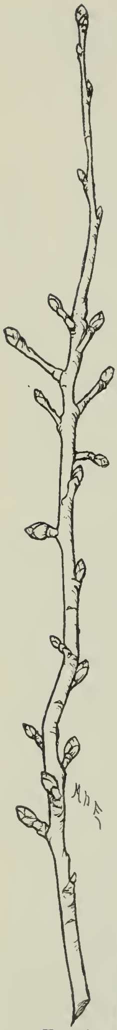
Station the plants have reached mature growth during July, although on good soil the spring growth of this clover may be cut and used for a mulch about the trees or plowed into the soil to good advantage early in June.

APPLE TREES NEED WATER.

If the supply of water in the soil in an orchard is deficient when the fruit is maturing, as it frequently is, the trees cannot produce a full crop of apples however well they may have been fed and otherwise cared for. The lack of a sufficient amount of water in the soil in orchards often is the cause of apples dropping prematurely and the ripening of winter fruit during the fall months. While it may be impracticable to attempt to supply water artificially in most cases, at least, to orchards in this State, yet much can be done by good management to prevent the needless escape of the natural supply, and in this way large quantities of water may be retained in the soil for the use of the trees when it is needed by them. A mulch of grass, leaves or other organic matter is useful for this purpose, and the ground in some cases may be cultivated in the open spaces to good advantage. In this connection we must enter a protest against the practice of trimming off the lower limbs of apple trees. This allows the wind to sweep through beneath them and the sun to shine in and dry up the soil over their roots. In the average orchard in Rhode Island these limbs should be spared if for no other reason than to retard the evaporation of moisture from the soil beneath the trees.

APPLE TREES USE SUNLIGHT.

In order to produce ten barrels of fruit as the product of one or two seasons' growth, an apple tree must do a large amount of work in collecting the crude materials required and in manufacturing them into such refined products as Gravensteins, Greenings or Baldwins. Sunlight, by its action upon the foliage, furnishes largely the power that runs the machinery of an apple tree. The amount of this power that a tree can use in a measure determines how much fruit the tree can bear. For this reason the surface area of the top of an apple tree should be as large and as well ex-



posed to the light as circumstances will allow. The natural habit of the apple tree is to form a rounded top with the branches bending low to catch as much sunlight as is possible. It is a too common practice to cut off these lower limbs, which may in the case of a well-grown tree represent from 400 to 800 square feet of the normal bearing surface of the top, and in this way to permanently injure the trees. It is as important for an apple tree that is to do its best work to have its top adjusted to use the light as it is for a sailing vessel to be trimmed to catch the wind. Save the lower limbs that increase the surface area of the top, for these when the roots are well cared for enlarge the bearing capacity of the tree, but thin out and when necessary shorten in the limbs that the light may shine brighter on those which are left.

SUNLIGHT AND FRUIT BUDS.

Limbs of apple trees that are exposed to strong light produce more fruit buds than those which are in partial shade. In order to prove this we secured permission to go into an orchard where the trees although rather too near together were on the whole well grown, and cut two limbs from each of ten trees in different parts of the orchard. The limbs selected were about one inch in diameter and in each case one was taken that was fully exposed to sunlight and the other where partially shaded. When the limbs were taken to the laboratory where the buds were counted the action of the sunlight in promoting the formation of fruit buds was apparent. The results were as follows:

FIG. 4. *Twig from R. I. Greening tree grown in the sunlight. Fruit buds numerous.*

FIG. 5. *Twig from R. I. Greening tree grown in the shade. Fruit buds scattering.*

	Limbs in Sunlight.	Limbs in Partial Shade.
Tree No. 1—R. I. Greening.	194 clusters flower buds.	120 clusters flower buds.
" " 2— " "	295 " " "	226 " " "
" " 3—Var. not known.	112 " " "	82 " " "
" " 4—Early Harvest.	202 " " "	149 " " "
" " 5—Var. not known.	163 " " "	157 " " "
" " 6—Baldwin.	213 " " "	91 " " "
" " 7—Baldwin.	140 " " "	74 " " "
" " 8—Var. not known.	148 " " "	104 " " "
" " 9—Roxbury Russet.	238 " " "	232 " " "
" " 10—Pear Sweeting.	115 " " "	128 " " "
Average.	182 " " "	136 " " "

Altogether 3,183 clusters of blossom buds were found on the twenty branches. Of these 1,820 were upon the limbs which grew in bright light and 1,363 were upon the limbs that grew in partial shade, or there was an average of 46 more clusters of blossom buds upon a limb that grew in the sunlight than upon a similar limb from the same tree that grew in the shade. There appeared to be no other cause for the difference in the number of flower bud clusters upon the limbs other than the difference in their exposure to light. There was no difference in the average diameters of the two lots of limbs, that of each being $1\frac{1}{16}$ of an inch, but the limbs that grew in partial shade averaged 6 oz. each heavier than the limbs that grew in the sunlight; the average weights being respectively 2 lbs. and 13 oz. and 2 lbs. and 7 oz. Florists find that sunlight will bring out the blossom buds for them if their plants are otherwise well cared for, and it appears that it will do the same thing for those who have apple trees when it is given a chance. When apple trees are planted too close together the surface area of their tops exposed to the bright light often becomes greatly reduced. The limbs of the different trees meet at first low down but gradually they come together higher and higher up, and as a result the lower branches die off and the tops become crowded and more and more nearly flat. By skilfully shortening in and thinning the branches of such trees their tops can be restored to a more nearly normal conical form, and in this way their bearing capacity can often be greatly increased. While generally it may be better to begin at the bottom to renovate an orchard, in such cases as these it is apparent that the tops of the trees should be attended to first and their roots fertilized later. With the present competition in the production of apples, trees with crowded tops are in poor condition to use fertilizers and yield profitable returns from them.

APPLE TREES NEED TO BE SPRAYED.

Experience has shown that there are certain insects and fungi that annually attack both the fruit and the foliage of the apple in this region unless they are protected by some artificial means. Spraying the trees is the best way at present known of affording them protection from attacks of these enemies which is necessary to enable them to perfect their fruit unmolested. The best results are obtained from spraying trees when there is no deficiency of plant food or moisture in the soil and when the tops of trees are fully exposed to the sunlight. To spray neglected apple trees that have not been fertilized or pruned for years may be labor lost and time misspent, but there is little danger of this if the trees have been otherwise well cared for. It is the course for the grower to pursue in order to secure the full reward for other care that he gives his trees.

FIG. 6.

A profitable Rhode Island Greening tree in Lincoln, R. I., that has not been "trimmed up." Spread of branches 35 feet, height 30 feet.

THE BORDEAUX MIXTURE WITH PARIS GREEN.

This is now after several years trial very popular among those who have used it as spray for apple trees. The fungous and in-

sect pests of the orchard are numerous, but the Bordeaux mixture and Paris green combination appears to be a common remedy for all of the most important ones excepting the apple maggot and perhaps the curculio; and in many cases even the depredations of these insects appear to have been almost entirely prevented by its use. From what information there is at present accessible upon the subject it seems best to spray apple trees about three or four times with this combined fungicide and insecticide each season, the first application being made after growth has begun in the spring but before the blossom buds open; the second immediately after the trees pass out of blossom, and the third as soon after the second as may be necessary in order to keep the fruit and young growth constantly protected. The aim in this work should be to keep some of the substances continually on the young foliage and fruit during the parts of May and June when the insect and fungous pests are most active. To do this in wet seasons sometimes requires the persistent use of the spray pump in the orchard during the time, but in such cases this is the price of fair apples.

FIG. 7.
Roxbury Russet tree showing the normal shape of the top.

The Bordeaux mixture with Paris green as prepared by different parties in the State varies considerably in composition, but it al-

ways consists of a Bordeaux mixture to which more or less Paris green has been added. Individual preferences regarding formulas for making the Bordeaux mixture as well as the proportion of Paris green to be added to it occur, but these are of minor importance, as the fungicidal and insecticidal ingredients of all of the preparations are the same,—the principal differences in them being the variable proportion of lime which they contain and the degree to which they are diluted with water. By some, considerable surplus lime in the Bordeaux mixture is regarded with favor because it is believed by them that the free lime increases its adhesive properties; but others object to the presence of much extra lime because it is believed by them that it increases the cost of putting on the mixture more than the proportional benefit that they receive from it. However this may be, it is always better to have too much than too little lime in the Bordeaux mixture, and when Paris green is to be added a little extra lime is required. At the Experiment Station the formula that has generally been used in preparing the Bordeaux mixture and Paris green combination for use upon apple trees is as follows:

Copper sulphate......	6 lbs.
Lime.................	4 lbs.
Water................	22 to 40 gollons.
Paris green..........	1 oz. to each 10 gallons, or about $\frac{1}{4}$ lb. to a barrelful of the mixture.

The most complete protection of the trees has been secured when only 22 gallons of water have been used, although the addition of a larger amount reduces the cost per gallon, and with some apparatus the diluted mixture can be applied with less difficulty than the more concentrated.

THE APPLE MAGGOT OR RAILROAD WORM.

The injuries of this insect appear to be rapidly increasing year by year in this State. Formerly it was known to attack here only the fruits of a limited number of varieties, among which are the Porter, Seek-No-Further, Garden Royal and a few other subacid fall apples. Now the Baldwin, R. I. Greening, and other winter kinds are no longer exempt from damage by it, while the fruit of thousands of trees of the sub-acid varieties is rendered entirely unfit for either table or culinary use by the presence of the

maggots. Numerous cases have been reported where spraying the trees very heavily several times during the growth of the fruit with the Bordeaux mixture and Paris green has appeared to prevent all serious injuries from this insect. Yet at present there is not sufficient proof of the efficiency of this as a reliable remedy for the apple maggot to justify confidence in it. Some special treatment seems to be required. In its mature stage this insect is a fly which cannot readily be poisoned and it is supposed that the eggs which produce the maggots are deposited by the flies in the pulp of the apple beneath the skin so that the young maggots are secure within the fruit from the time the eggs are laid until they are mature and emerge from the apple to go into the ground. Infested apples have been brought into the laboratory at different times and the habits of the maggots studied, but less is known about the habits of the mature flies when they have their liberty. These are not as large as the common house fly and although of peculiar appearance they are seldom seen by ordinary observers.

Numerous requests were received at the Experiment Station last fall for information concerning remedies for this pest, but no positive advice could be given. Soil was collected from definite areas beneath a number of trees where the fruit had been attacked by the maggots and taken to the laboratory where it was sifted and carefully examined. By this preliminary work it was found that large numbers of the maggots were then lying in the pupa stage just beneath the surface soil among the grass roots. Altogether soil was collected from beneath eight trees in different localities. The area from which the soil was taken was six inches square and the depth one-half inch. The number of pupæ found was as follows:

Tree No. 1.—Yellow Bellflower	5 pupae,	Fruit	worthless.
" " 2.—Early Harvest	3 "	"	very wormy.
" " 3.—Pear Sweeting	1 pupa,	"	but little wormy.
" " 4.—Baldwin	0 "	"	slightly wormy.
" " 5.—R. I. Greening	1 "	"	" "
" " 6.—Red Astrachan	6 pupae,	"	worthless.
" " 7.—Late Strawberry	6 "	"	"
" " 8.—Golden Ball	1 pupa,	"	about ¼ wormy.

From the above data the number of maggots that were secreted under the different trees was estimated according to the size of the trees as follows:

Tree No. 1	12,500.
" " 2	4,800.
" " 3	1,600.
" " 4	0
" " 5	1,600.
" " 6	9,600.
" " 7	9,600.
" " 8	1,600.

When thus secreted beneath the trees these insects are about the size of and somewhat resemble in appearance kernels of wheat, and it occurred to us that perhaps poultry would pick them up if confined to a small range and encouraged to scratch for their living. In order to test this experimentally it was arranged with Mr. Samuel Adams to provide a movable wire fence of suitable size to enclose a large apple tree. When this was in place about a tree where the fruit had been destroyed by the maggots, one side

FIG. 8.

Fifty head of poultry feeding under apple tree, the fruit of which had been destroyed by apple maggots.

of the fence was raised and the hens that were about the place were called into the enclosure and fed. The side of the fence was then let down and as soon as the grain was picked up the poultry immediately began to see what else could be found among the grass roots. How many of the maggots were discovered and

picked up by the hens during the three or four days that they scratched beneath each infested tree we cannot yet tell, but the hens worked faithfully, and it appeared as if but few of the maggots were likely to be overlooked by them.

It is probable that the apple maggots remain in the pupa state in the soil beneath the trees in this latitude from the time they leave the apple in the fall until the following spring. Even in the warm laboratory the maggots that pupated in August remained in the pupa stage until February, when the flies began to appear. Thus the poultry method of attacking them seems to be applicable over a considerable length of time, and we would suggest a trial of it by those who have poultry and are troubled with this insect.

THE SAN JOSE SCALE.

The movement of this scale from the Pacific coast eastward has been watched by fruit growers with considerable anxiety. It has now been found in New York, New Jersey, Delaware and Massachusetts, and is liable to appear in this State at any time. It occurs upon the apple, pear, peach, plum, persimmon, currant and Japan quince. "The San Jose scale differs from all others in the peculiar reddening effect which it produces upon the skin of the fruit and tender twigs. This very characteristic feature of the insect's work renders it easy to distinguish. . . . When occurring in winter in large numbers upon the bark of a twig the scales lie close together, frequently overlapping and are at such times difficult to distinguish without a magnifying glass. The general appearance which they present is a grayish, very slightly roughened, scurfy deposit. The rich reddish color of the twigs of the peach and apple is quite obscured when these trees are thickly infested, and they have every appearance of being coated with lime or ashes."[1]

Any information relating to the discovery of this scale in this State will be appreciated at the Experiment Station.

SUMMARY.

1. The recent awakening of interest in apple culture seems to be largely attributable to the discovery and use of effectual means

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[1] L. O. Howard. Year-book of the U. S. Dept. of Agriculture, 1894, p. 270.

for controlling the insects and fungi that attack the foliage and fruit of the trees.

2. Better culture of apple orchards increases the crop of fruit, but improved methods of storing, canning, evaporating and making jellies proportionately increases the demand for apples.

3. Apple trees should be regarded as cultivated plants and regularly supplied with plant food. Neglected apple trees are often barely able to maintain their own existence and frequently yield their owners little or nothing to pay for the use of the land which they occupy.

4. The roots of a mature apple tree extend both wide and deep. In applying fertilizers to neglected trees spread them also both wide and deep so that they will reach the entire root systems.

5. Crimson clover appears to be a valuable catch crop for summer sowing in the apple orchard, although thus far it has not proved hardy at the Experiment Station. (See page 33).

6. The apple is a moisture-liking tree. The lack of a sufficient supply of water in the soil is often the cause of apples falling, and, indirectly, of winter varieties decaying prematurely.

7. Mulching the ground beneath the trees prevents rapid evaporation of the moisture from the surface, and if the tops of the trees are allowed to shade the ground and prevent the free movement of currents of air over the roots during drouths, the value of the mulch is increased.

8. It is better to retain the conical form of the tops of apple trees by thinning out and, when necessary, shortening in the limbs than to allow the branches to interlace, which generally results in decreasing the bearing capacity of the trees.

9. Individuality exists in the natural form of the tops of the different varieties of apple trees, but all kinds are alike in requiring large surface areas of the tops exposed to the light in order to produce large crops of fruit.

10. The Rhode Island Greening naturally forms a more spreading top than the Baldwin or Roxbury Russet, but the limbs of these two latter kinds generally droop nearly to the ground, if this is permitted, when the trees are mature. (See Figs. 3, 6 and 7).

11. There is generally but little growth of grass or other plants beneath spreading and well-formed apple trees, consequently there is little need of driving teams under the trees to cultivate the soil. Cutting off the limbs to make way for a team may injure the top more than the cultivation will benefit the roots.

12. Cultivation of the open spaces in an apple orchard increases the vigor of the growth and usually the productiveness of the trees. (See illustration on cover).

13. Strong light promotes, and the interlacing of the branches of adjoining trees is unfavorable to, the formation of fruit buds on the twigs of apple trees. (See Figs. 4 and 5).

14. A large proportion of the fruit of unsprayed apple trees is damaged by insects and fungi. By properly spraying the trees with the Bordeaux mixture to which Paris green has been added the crop can be secured for the use of the owner.

15. The codling-moth, canker worms and the apple scab fungus are all active during the latter part of May and the first part of June in this latitude, and this is the time to keep the young growth of trees covered with substances that will protect it from the attack of these enemies.

16. Spraying the trees of some sub-acid fall varieties in the ordinary manner with the Bordeaux mixture and Paris green does not appear to insure a crop of fruit that is free from the apple maggots. It is possible that poultry can be used to good advantage in destroying this insect until some better way is discovered. (See page 42).

Bulletin 38. June, 1896.

KINGSTON, RHODE ISLAND.

THE BORDEAUX MIXTURE.

ITS USE IN THE POTATO FIELD.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

PRESS OF E. L. FREEMAN & SONS, PRINTERS TO THE STATE.

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RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 38.

THE BORDEAUX MIXTURE.

ITS USE IN THE POTATO FIELD.

L. F. KINNEY.

One of the most disheartening experiences that can befall a man who is making a business of growing a particular garden or farm crop, is to witness the failure of such a crop when he does not know what to do to prevent the loss. Such an experience quenches one's enthusiasm in his work, temporarily at least, and weakens his faith in his ability to overcome the obstacles that he must meet in his business. The recurrence of such experiences has often been the direct cause of the growth of one crop after another being abandoned; and occasionally this has resulted in New England in the abandonment of the farm altogether.

On the other hand, to feel that one understands the peculiarities of plants and knows what to do for them and when to do it if they are threatened with disaster, begets a certain confidence in the occupation, and in turn this fosters an ambition to cultivate more crops and larger fields and to increase the production of each square foot of land so tilled.

The discovery of the Bordeaux mixture and its plant-disease preventing qualities promises to be of great value to those engaged in the cultivation of the soil, enabling them to control in a large

measure a class of troubles which have in the past been the occasion of heavy losses and trying annoyances.

LATE POTATOES.

The planting of late potatoes has fallen into disfavor in Rhode Island on account of the occasional prevalence of the late blight which hitherto in some seasons has run riot in the potato fields, while the owners of the fields could do nothing but stand by and see their potato vines wither and blacken and their prospects of securing a good potato crop grow small by degrees and beautifully less. Experience has shown that potato growers can now save their late crop from destruction by this disease; but in order to do this they must introduce into their methods of culture when necessary a feature that is comparatively new to the business—a kind of work the details of which are perfectly simple, but they are unlike any operations that have formerly been practiced upon the farm, and consequently they must be learned mainly by the experience and observation of those who are to practice them.

SPRAYING THE VINES.

This operation involves the preparation of the mixture or the dissolving of sulphate of copper and the slaking of quicklime in water, and in separate and preferably wooden receptacles, barrels, tubs or pails. Equal weights of lime and copper diluted with water at the rate of from four to eight gallons to each pound of sulphate of copper makes a good Bordeaux mixture for potato vines. Both of the liquids should be passed through a fine strainer and they should not be mixed until the milk of lime is perfectly cold. The Bordeaux mixture when prepared in this way should be of a peculiar light blue color. Some sort of a machine must be used to distribute the mixture evenly and thoroughly

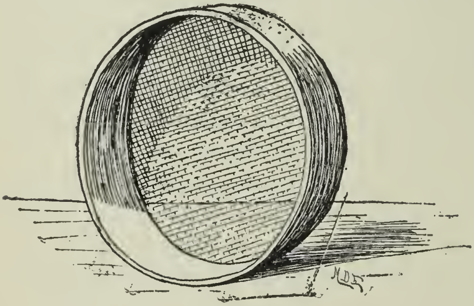

FIG. 1.
*Home-made strainer for use in preparing the Bordeaux mixture.**

* Made from a wooden measure and a piece of brass wire cloth with about 40 meshes to the inch. Meshes finer than shown in the sketch.

over the plants. The simpler the construction of such a device the better, if it will serve the purpose. Experience has proved that when ready-made spraying outfits are put into actual service they constantly need repairs. It is important that the person who is working the outfit should be able to make the necessary repairs without laying the machine, of whatever kind it may be, off duty. By buying the essential parts and fitting up a rig according to one's own ideas, a person becomes perfectly familiar with its construction, and is not only able to renew packings, tighten joints, fix valves, and put on new washers when necessary, but he can from time to time make such alterations in his outfit as he may require. All of the essential parts of a first-class spraying outfit can be obtained separately from those who manufacture them, and the ordinary pipe, fittings, etc., and the assistance that may be necessary in completing the outfit can be secured from the local plumber or other source at a moderate expense. Home-made spraying outfits are liable to develop defects, but these can usually be remedied with but little trouble. The man who has fitted up his own spraying rig can operate it to a better advantage than the man who has purchased his outfit complete and knows but little about how it is made. Besides this, by utilizing one's resources considerable expense can often be saved.

Spraying the vines appears occasionally to be necessary to prevent them from blighting, but the pattern of the machine that is used for the purpose is a matter of secondary importance so long as the work is done well and with reasonable rapidity, and after all this depends very largely upon the judgment and tact of the person who is operating the machine, however simple or complicated it may be. Spraying outfits are often used but a few times in a season; during the remaining part of the year they are "rusting out" with the numerous other machines upon the farm. Generally the more complicated the machine the faster it deteriorates in value, and for this reason the outfit that will spray an acre of potatoes the quickest may prove the dearest one to use in the end.

SYMPTOMS OF THE LATE BLIGHT.

It is important that the disease should be recognized in its early stages, and while the cause may lie beyond the sight of the ordinary observer the symptoms are readily noticed. The tissue in

mature leaves suddenly dies in large patches and these patches turn a conspicuous dark color. The tissue in the blighted spots is at first soft and emits a peculiar odor which can frequently be detected at some distance from the potato field. Growers have learned by sad experience that this odor often forbodes a calamity to their late potato crop, although their vines may be apparently green and vigorous.

Other crops may yield larger profits than late potatoes in seasons when the blight is prevalent, but if the growth of this crop is attempted it is not a prudent policy to abandon all work in the fields if the blight happens to appear in them. The crop has cost too much by the time that it is attacked by the blight to surrender it up without a contest. While the leaves are green they can be saved, but the treatment must correspond in thoroughness with the acuteness of the attack of the disease.

FIG. 2.

Potato vine with leaves blackened by the blight at b. b. and other places, showing the condition of the vines in the field of Late Beauty of Hebron, July 6th.

THE ODOR A SIGNAL FOR ACTION.

Those who have late potatoes in Rhode Island should look out for this signal during July and it may occasionally come in the latter part of June. An outbreak of the blight often follows a

sudden change in the temperature of the air and the disease progresses most rapidly in damp weather.

Until last year we have planned in our use of the Bordeaux mixture in the potato field to spray the vines with the mixture at least once before any signs of the blight appeared, but this practice is obviously open to objections. It is working by rule instead of according to the dictates of one's judgment. Sometimes no treat-

FIG 3.
Condition of potato vines, July 20th, when sprayed the fourth time.

ment of this kind is necessary, and if given it may prove almost a complete waste of labor and needless expense. At other times the two or three applications of the mixture that are ordinarily prescribed may not be enough to save the crop. Perhaps it will prove profitable in this work to recall the instructions said to have been given to the Colonial soldiers before the battle of Bunker Hill: "Save your ammunition until you see the whites of the eyes of the enemy and then take good aim."

EXPERIENCE AT THIS STATION IN 1895.

Last season the use of the Bordeaux mixture in the potato field at this Station was deferred until it was evident that there was need of it. Although the disease was discovered lurking in several places in a field of Late Beauty of Hebron potatoes on July 1st, no treatment of any kind was given until July 6th, after

the general outbreak of the disease that followed the heavy rain on July 4th. At this time the blackened patches were numerous upon the lower leaves of the vines all over the field, and the odor which arose from the field could be detected fifty rods away. July 6th was a wet day, and on July 7th over an inch of rain fell which washed off most of the mixture that had been sprayed over the vines the preceding day. July 8th was another damp day but the vines were sprayed again. On the following day, July 9th, more rain fell which washed most of the mixture from the vines again. July 10th the vines were again

FIG. 4.
Condition of the potato vines, August 25th.

sprayed, this being the third time in five days. After this, fair weather prevailed until July 16th and 17th, when more rain fell. July 20th and afterward during the month of August the potato vines were sprayed three times, making seven applications of the mixture during the season. This represents the number of times that it appeared necessary to use the Bordeaux mixture in this particular field in order to completely save the crop. This treatment did not drive the disease from the field, but it so hampered its progress that the potato plants were able to outrun it and mature their tubers perfectly.

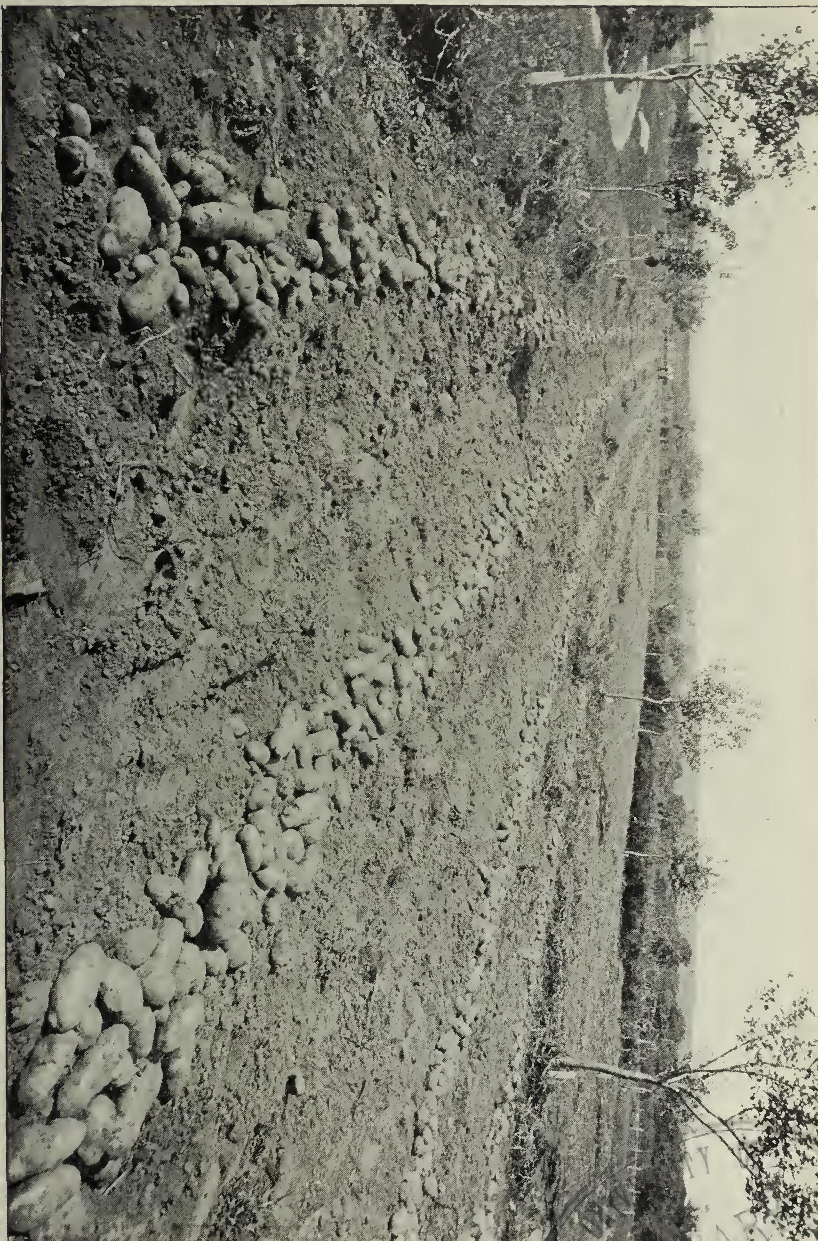

FIG. 5.

A full crop of potatoes, in spite of the blight. 236¾ bushels from a little less than two-thirds of an acre.

STRUGGLE FOR EXISTENCE.

After the potato plants were attacked by the disease it was apparent that a constant struggle for existence was going on in the field. Where there was a coating of the Bordeaux mixture over the green tissues, the blight could not enter, but during foggy nights and damp days it spread with marvelous rapidity to all parts of the plants that were not protected. Each storm laid open innumerable channels for the attack of the disease, and although we intended to cover these again as soon as possible, the green growth of the plants appeared invariably to shrink away during wet weather, but when fair weather prevailed again new leaves were always sent out, and gradually the vines recovered their normal vigor. This alteration in the appearance of the vines continued until the end of the season.

PREVALENCE OF THE LATE POTATO BLIGHT IN RHODE ISLAND IN 1895.

Heavy losses from this cause were experienced by growers of potatoes all over the State and here in the South County the disease was particularly destructive. If a single field of late potatoes in the county, except the one at the Experiment Station, escaped serious injury by the blight, we are not aware of the fact. The potatoes in some fields were not dug, and in many others they were scarcely worth digging. Yet the crop promised unusually well early in the season, and had the fields not been visited by the blight there would have been generally a heavy yield of tubers.

In the treatment of the field referred to various pumps, nozzles, and methods of applying the Bordeaux mixture were used. These features of the work have a bearing upon the cost of the treatment because the main part of the expense is for labor, but they do not affect the disease-preventing qualities of the mixture, which it was our object in this case to demonstrate again on a larger scale than had ever before been attempted at this Station. As in the case of other implements, some spraying outfits are better than others, but the most important lesson to learn in connection with the use of the Bordeaux mixture in the potato field is *what constitutes a thorough treatment of the vines.* A man equipped with this information and a poor outfit is better prepared to save his crop than the man who has a first-class outfit but does not know how to use it.

The vines must be thoroughly covered with a film of the Bordeaux mixture in order to be sure of saving them when the blight is as prevalent as it was last season. This coating can readily be seen after the vines have dried off and if it is found imperfect the machine should be fixed, the method changed, or the operation repeated until the job is well done. Spots of the mixture here and there upon scattering leaves may do some good, but spraying a field in this way is—like hoeing it and leaving three-fourths of the ground undisturbed—of little use if there is real need of the operation.

SUMMARY.

1. Losses caused by the late blight have discouraged the planting of late potatoes extensively in Rhode Island.

2. The discovery of the Bordeaux mixture and its disease-preventing qualities may in a measure restore the confidence of growers in this crop.

3. Equal parts of quicklime and sulphate of copper with four to eight gallons of water for each pound of the sulphate of copper make a good Bordeaux mixture for use in the potato field.

4. Both the sulphate of copper solution and the milk of lime should be passed through a fine strainer before they are mixed together.

5. A serviceable strainer for this purpose can be made from a wooden measure and a piece of very fine brass wire gauze.

6. The milk of lime should be cold before it is mixed with the copper solution, otherwise the true Bordeaux blue color may not be secured.

7. Spraying the vines is comparatively a new feature in potato culture. Ready-made complete spraying outfits can be obtained for the purpose, or a pump and such fittings as are necessary may be purchased separately and a rig fitted up according to one's own ideas.

8. The pattern of the spraying outfit neither increases nor decreases the disease-preventing qualities of the mixture. A field well sprayed with a poor outfit is more secure from injury by the blight than a field that is poorly sprayed with a good outfit.

9. Spraying a potato field involves the handling of a large amount of water. It pays to see that there is not unnecessary loss of time and waste of labor in doing this.

10. Easily recognized symptoms of the late blight are: the sudden blackening of large patches in mature leaves, and a peculiar odor in the potato field that is given off by the decaying tissue of the leaves.

11. It has formerly been supposed that in order to have the use of the Bordeaux mixture in the potato field successful the treatment must begin before there is a general outbreak of the blight in the field. Experience at this Station last season indicates that the supposition is incorrect.

12. The blight was more prevalent in this locality last year than at any other time since the establishment of this Station.

13. So far as we know at the present time not a single field of late potatoes in this county, except the one at the Experiment Station, escaped being more or less seriously injured by the disease.

14. Although it was known that potato vines were blighting in the neighborhood and also that the disease was present in isolated places in the field at the Experiment Station, treatment of the vines was deferred until after there was a general outbreak of the trouble that followed the heavy rain on July 4th.

15. Rainy weather made it necessary to spray the vines three times during the first five days after the treatment began in order to keep them well covered with the mixture.

16. During the remainder of the season the vines were sprayed four times. With this treatment the blight did not injure the crop appreciably.

17. Many potato growers visited the field during the season, and after inspecting the vines none of them expressed any doubts about it being possible, as long as the potato plants retained vitality, to perfectly control the blight by proper use of the Bordeaux mixture.

Bulletin 39. July, 1896.

KINGSTON, RHODE ISLAND.

ANALYSES

OF

COMMERCIAL FERTILIZERS.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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* Five-sixths of time devoted to college work.

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RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 39.

ANALYSES OF COMMERCIAL FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL, AND C. L. SARGENT.

The commercial value of fertilizers for this season is nothing more nor less than a statement of the average price at which the same amounts of potash, phosphoric acid and nitrogen in the best form of chemicals and fertilizer stock, could have been bought at retail in our larger markets during the six months preceding March 1, 1896.

The schedule of prices on page 68 used in estimating the commercial value of fertilizers is that adopted by the Connecticut, Massachusetts, New Jersey and Rhode Island Agricultural Experiment Stations for the year 1896, and represents the average prices in our larger markets for the six months preceding March 1. In the case of wholesale quotations about 20 per cent. has been added to raise them to a retail basis.

The difference between the commercial valuation and the cost of the fertilizer goes to cover grinding and mixing, interest on investment, freight, rebagging, agents' commissions, bad bills, etc., and finally, profits. It remains for the individual farmer to decide whether he will pay the difference or buy his chemicals and mix his own fertilizers. The cost of mixing, as estimated by Rhode Island farmers who have tried it, varies from $0.50 to $1.50 per ton.

For information in relation to the headings used in the succeeding tables of analyses, and for a discussion of the special value of the various forms of nitrogen, phosphoric acid and potash, see BULLETIN 16, pages 35–37.

GROUND BONES AND TANKAGE.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
582	Bradley's Fine Ground Bone	Bradley Fert. Co., State st., Boston	J. S. Thornley, East Greenwich.
683	Calef Bros.' Ground Bone	Calef Bros., 79 No. Main st., Prov., R. I.	Calef Bros., Providence.
676	Calef Bros.' Tankage	Calef Bros., 79 No Main st., Prov., R. I.	Calef Bros., Providence.
629	Clark's Cove White Oak Pure Ground Bone	Clark's Cove Fert. Co., State st., Boston	Chas. H. Ward, Middletown.
686	Cooper's Bone Dust	P. Cooper's Glue Factory, Box 1468, N.Y.	W. A. Potter & Co., Providence.
643	Darling's Fine Ground Bone	L. B. Darling Fert. Co., Pawtucket, R. I.	H. W. Potter, Riverpoint.
554	National Fert. Co.'s Blood, Bone and Meat	National Fert. Co., Bridgeport, Conn	F. D. Madison, East Greenwich.
553	National Fert. Co.'s Chittenden's Ground Bone	National Fert. Co., Bridgeport, Conn	F. D. Madison, East Greenwich.
605	Sanderson's Blood, Bone and Meat	Lucien Sanderson, New Haven, Conn	C. H. Knowles, Point Judith.
625	Shoemaker's Swift Sure Bone Meal	M. L. Shoemaker & Co., Philadelphia, Pa.	Geo. A. Weaver Co., Newport.
694	Wilcox's Pure Ground Bone	Wilcox Fertilizer Works, Mystic, Conn	A. H. Tefft, Davisville.

GROUND BONES AND TANKAGE.

Sample No.	Name of Brand.	Total nitrogen found.	Total nitrogen guaranteed.	Total phosphoric acid found.	Total phosphoric acid guaranteed.	Mechanical Analysis. Finer than one-fiftieth inch—(fine).	Finer than one-twenty-fifth inch—(fine medium).	Finer than one-twelfth inch—(medium).	Coarser than one-twelfth inch—(coarse).	Valuation of the nitrogen and phosphoric acid in one ton.
582	Bradley's Fine Ground Bone	3.11	2.50	19.37	21.00	48.2	29.8	22.0	......	$23.59
683	Calef Bros.' Ground Bone	2.86	......	23.63	......	60.0	20.0	16.2	3.8	27 14
676	Calef Bros.' Tankage	9.73	....	12.26	......	32.6	31.8	22.5	13.1	29.83
629	Clark's Cove White Oak Pure Ground Bone	3.20	2.47	19.83	20.00	49.0	29.1	21.9	......	24.23
686	Cooper's Bone Dust	1.72	2.50	28.41	22.67	65.1	14.1	11.6	9.2	28.46
643	Darling's Fine Ground Bone	2.66	2.50	23.56	20.00	70.7	18.1	11.2	......	28.16
554	National Fertilizer Co.'s Blood, Bone and Meat	7.33	5.77	11.36	9.00	59.7	24.4	14.4	1.5	27.96
553	National Fertilizer Co.'s Chittenden's Ground Bone	1.74	2.88	28.32	20.00	79.3	15.0	4.8	9	31.24
605	Sanderson's Blood, Bone and Meat	6.43	5.77	12.54	10.00	55 8	21.1	17.0	6.1	25.63
625	Shoemaker's Swift Sure Bone Meal	5.13	4.12	22.62	20 60	71.2	22.9	5.9	......	34 15
694	Wilcox's Pure Ground Bone	3.84	3.00	22.89	20 00	35.2	22.8	27.3	14.7	24.68

Sample No.	Name of Brand.	Manufacturer.	Dealer.
574	Baker's Complete Potato Manure	H. J. Baker & Bro., 93–97 William st., N. Y.	E. O Easterbrooks, Warren.
559	Bradley's Complete Manure for Potatoes & Vegetables	Bradley Fert. Co., State st., Boston	Seymour Bros., Warren.
679	" Complete Manure with 10 per cent. Potash	Bradley Fert. Co., State st., Boston	M. M. Aldrich, Middletown.
586	" Potato Manure	Bradley Fert. Co., State st., Boston	J. S. Thornley, East Greenwich.
627	" Special Manure for Potatoes and Vegetables	Bradley Fert. Co., State st., Boston	L. H. Peabody, Middletown.
619	Brightman's High Grade Potato and Root Manure	W. J. Brightman & Co., Tiverton, R. I.	F. P. Babcock, Westerly.
591	Bowker's Potato Phosphate	Bowker Fert. Co., 43 Chatham st., Boston.	H. W. Partelow, Wakefield.
689	" Potato and Vegetable Manure	Bowker Fert. Co., 43 Chatham st., Boston.	P. B. Wilbur, Central Falls.
678	" R. I. Potato Manure	Bowker Fert. Co., 43 Chatham st., Boston.	Seth Anthony, Portsmouth.
570	" Stockbridge Manure for Potatoes & Vegetables	Bowker Fert. Co., 43 Chatham st., Boston.	Wardwell Lumber Co., Bristol.
630	Clark's Cove Bay State Potato Manure	Clark's Cove Fert. Co., State st., Boston	Chas. H. Ward, Middletown.
699	Cleveland Dryer Co.'s Potato Phosphate	Cleveland Dryer Co., Cleveland, O.	Lewis C. Grinnell, Kingston.
607	Coe's Special Potato Fertilizer	E. Frank Coe, 16 Burling Slip, New York.	Sullivan & Perry, Shannock.
613	Crocker's Potato, Hop and Tobacco Phosphate	Crocker Fert. and Chem. Co., Buffalo, N.Y.	S. P. Nichols, Westerly.
692	" Special Potato Manure	Crocker Fert. and Chem. Co., Buffalo, N.Y.	P. B. Wilbur, Central Falls.

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.			
												Available.					
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
574	Baker's Complete Potato Manure....	.61	1.21	1.95	**3.77**	*3.30*	5 22	1.44	.92	**7.58**	*6 75*	**6.66**	*5.75*	**10.31**	*10.0*	6.30	*$27.76*
559	Bradley's Complete Manure for Potoes and Vegetables..............	1.40	....	2.25	**3.65**	*3.73*	4.30	4.49	2.34	**11.13**	*9.0*	**8.79**	*8.0*	**5.57**	*6.0*	*	*25.25*
679	Bradley's Complete Manure with 10 per cent. Potash................	1.51	....	1.79	**3.30**	*3 30*	3.13	3.86	2.34	**9.33**	*7 0*	**6.99**	*6.0*	**10.80**	*10.0*	*	*27.05*
586	Bradley's Potato Manure............	.87	....	1.79	**2.66**	*2.50*	2.78	3.23	2.05	**8.06**	*8.0*	**6.01**	*6.0*	**5.24**	*5.0*	*	*19 19*
627	Bradley's Special Manure for Potatoes and Vegetables......	1.36	....	2.23	**3.59**	*3.30*	3.91	5.23	1.36	**10.50**	*8.0*	**9.14**	*7.0*	**7.19**	*7.0*	*	*26.45*
619	Brightman's High Grade Potato and Root Manure..................	1.37	....	2.17	**3.54**	*3.30*	3.19	5.18	2 35	**10.72**	*9.0*	**8.37**	*8.0*	**7.00**	*7.0*	*	*25.71*
591	Bowker's Potato Phosphate.........	42	...	1.40	**1.82**	*1.50*	4.48	3.59	4 21	**12.28**	*10.0*	**8.07**	*8.0*	**2.48**	*2.0*	*	*17.48*
689	Bowker's Potato and Vegetable Manure.........................	.71	....	1.79	**2.50**	*2.50*	8.21	2.26	1.80	**12.27**	*10 0*	**10.47**	*8.0*	**4.60**	*4.0*	*	*23.08*
678	Bowker's R. I. Potato Manure......	1.18	....	2.55	**3.73**	*3.25*	3.49	2.51	2.88	**8.88**	*8 0*	**6.00**	*6.0*	**7.42**	*7.0*	*	*24.51*
570	Bowker's Stockbridge Manure for Potatoes and Vegetables......	1.42	...	2.13	**3.55**	*3.25*	3 26	2.01	3.47	**8.74**	*8.0*	**5.27**	*5.0*	**9.52**	*10.0*	*	*25 35*
630	Clark's Cove Bay State Potato Manure.........................	.81	....	1.80	**2.61**	*2 47*	2.69	3.04	2.64	**8.37**	*7.0*	**5.73**	*6.0*	**5.21**	*5.0*	*	*18.98*
699	Cleveland Dryer Co.'s Potato Phosphate......................	.63	...	1.42	**2.05**	*2.05*	3.98	4.36	2.56	**10.90**	*10.0*	**8.34**	*8.0*	**3.19**	*3.0*	*	*18.31*
607	Coe's Special Potato Fertilizer.......	....	.32	1.67	**1.99**	*1.65*	7.24	1.77	3 28	**12.29**	*11.0*	**9.01**	*9.0*	**3.75**	*3.5*	.10	*20.42*
613	Crocker's Potato, Hop and Tobacco Phosphate.....................	....	....	2.33	**2.33**	*2.00*	4 49	5 63	1.57	**11.69**	*11 0*	**10.12**	*10.0*	**3.68**	*3.25*	*	*21.03*
692	Crocker's Special Potato Manure....	.15	....	3.88	**4.03**	*3.70*	5.28	2.21	1.85	**9.34**	*9.0*	**7.49**	*8.0*	**5.85**	*5.4*	*	*25.30*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.
[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.
[2] The schedule of prices used in estimating these values is to be found on page 68.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
583	Cumberland Potato Fertilizer.	Cumberland Bone-Phos. Co., Portland, Me.	F. W. Sherman, Bellville.
674	Darling's Potato and Root Crop Manure	L. B. Darling Fert. Co., Pawtucket, R. I.	Darling Fert. Co., Pawtucket.
685	Lowell Fert. Co.'s Potato Phosphate	Lowell Fertilizer Co., Lowell, Mass	Martin Bros., Barrington.
564	Mapes Potato Manure	Mapes Formula & Peruv. Guano Co., N.Y.	Seymour Bros., Warren.
585	Mitchell's Potato Fertilizer	Mitchell Fertilizer Co., Tremley, N. J.	A. A. Wilbur, Allenton.
558	National Fert. Co.'s Fertilizer for Potatoes, Onions, etc	National Fert. Co., Bridgeport, Conn	Seth Paull, Bristol.
681	Pacific Guano Co.'s Special Potato Manure	Pacific Guano Co., Box 1368, Boston, Mass	D. D. Gifford, Bristol Ferry.
550	Parmenter & Polsey's Special Potato Manure	Parmenter & Polsey, Peabody, Mass	W. G. Rose, Slocumville.
565	Quinnipiac Potato Manure	The Quinnipiac Co., 92 State st., Boston.	Seymour Bros., Warren.
610	Russia Cement Co.'s Complete Manure for Roots and Vegetables	Russia Cement Co., Gloucester, Mass	F. P. Babcock, Westerly.
624	Shoemaker's Swift Sure Superphosphate for Potatoes	M. L. Shoemaker & Co., Philadelphia, Pa	Geo. A. Weaver Co., Newport.
651	Standard Fert. Co.'s Potato and Tobacco Fertilizer	Standard Fertilizer Co., State st., Boston	Searles Capwell, Anthony.
579	Wilcox's Onion, Potato and Tobacco Manure	Wilcox Fertilizer Works, Mystic, Conn	Seymour Bros., Warren.
632	Williams & Clark's High Grade Special for Potatoes, etc	Williams & Clark Fert. Co., 92 State st., Boston	Albert L. Chace, Middletown.
633	Williams & Clark's Potato Phosphate	Williams & Clark Fert. Co., 92 State st., Boston	Albert L. Chace, Middletown.

Sample No.	Name of Brand.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
583	Cumberland Potato Fertilizer.........	.49	....	1.61	**2.10**	*2.06*	4.20	4.82	2.88	**11.90**	*11.0*	**9.02**	*9 0*	**2.80**	*3.0*	*	*$18.94*
674	Darling's Potato and Root Crop Manure	.17	....	2.96	**3.13**	*3.00*	2.95	3.98	6.05	**12.98**	*10.0*	**6.93**	*6.0*	**8.48**	*7.0*	*	*26.03*
685	Lowell Fertilizer Co.'s Potato Phosphate	.73	....	1.95	**2.68**	*3.30*	1.98	4.11	2 85	**8.94**	*8.0*	**6.09**	*7.0*	**5.19**	*6.0*	*	*19 53*
564	Mapes' Potato Manure...............	1.78	.57	1 55	**3.90**	*3.71*	3.45	4.28	2.52	**10.25**	*8.0*	**7.73**	*8.0*	**7.34**	*6.0*	.80	*27.18*
585	Mitchell's Potato Fertilizer	2.15	....	2.86	**5.01**	*4.12*	5.63	1.72	1.45	**8.80**	*8.0*	**7.35**	*7.0*	**7.83**	*8 0*	.40	*30.09*
558	National Fert. Co.'s Fertilizer for Potatoes, Onions, etc..................	.62	.57	2.35	**3.54**	*3.30*	3 86	5.23	.92	**10.01**	*10.0*	**9.09**	*8.0*	**6.05**	*6.0*	*	*25.26*
681	Pacific Guano Co.'s Special Potato Manure...........................	.79	....	2.68	**3.47**	*2.47*	4.26	3.79	6.24	**14.29**	*7.0*	**8.05**	*5.0*	**3.82**	*5.0*	*	*24.05*
550	Parmenter & Polsey's Special Potato Manure....	.29	.42	2.53	**3.24**	*3.29*	3.34	4 91	2.34	**10.59**	*9.0*	**8.25**	*8.0*	**7.88**	*7.0*	3.70	*26.03*
565	Quinnipiac Potato Manure.....	.82	....	1.93	**2.75**	*2.47*	2.82	3.33	1.96	**8.11**	*7.0*	**6.15**	*6.0*	**5.39**	*5.0*	*	*19.67*
610	Russia Cement Co.'s Complete Manure for Potatoes, Roots and Vegetables..	.76	....	2.90	**3.66**	*3.71*	4.27	3 03	3.70	**11.00**	*9.0*	**7.30**	*7 0*	**7.99**	*8.5*	1 30	*27.20*
624	Shoemaker's Swift Sure Superphosphate for Potatoes.....................	1.04	...	1.72	**2.76**	*2.47*	3.98	5.73	3.30	**13.01**	*11.0*	**9.71**	*8.0*	**6.84**	*6.0*	*	*25.22*
651	Standard Fert. Co.'s Potato and Tobacco Fertilizer........................	.51	....	1.83	**2.34**	*2.05*	3.91	5.93	2.39	**12.23**	*9.0*	**9.84**	*8.0*	**3.07**	*3.0*	*	*20.45*
579	Wilcox's Onion, Potato and Tobacco Manure	1.32	....	2 51	**3.83**	*3.30*	6.16	1.51	2.06	**9.73**	*8.0*	**7.67**	*7.0*	**6.74**	*6.0*	.24	*26.41*
632	Williams & Clark's High Grade Special for Potatoes, etc	1.44	....	2.14	**3.58**	*3.70*	3.89	4.64	2.08	**10.61**	*8.0*	**8.53**	*7.0*	**7.00**	*7.0*	*	*25 93*
633	Williams & Clark's Potato Phosphate..	.76	.23	1.64	**2.63**	*2.47*	2 15	4.05	2 87	**9.07**	*7.0*	**6.20**	*6.0*	**5.35**	*5.0*	*	*19.71*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found on page 68.

AVERAGE RETAIL COST OF POTASH, PHOSPHORIC ACID AND NITROGEN IN THE FORM OF CHEMICALS AND FERTILIZER STOCK, FOR THE SIX MONTHS PRECEDING MARCH 1, 1896.

	Cents per Pound.
Nitrogen in ammonia salts	15
" " nitrates	13½
Organic nitrogen in dry and fine ground fish, meat, blood, and bone in high grade mixed fertilizers	14
Organic nitrogen in cotton-seed meal	12
" " fine bone and tankage	13½
" " fine medium bone and tankage	12
" " medium bone and tankage	9
" " coarser bone and tankage	3
" " hair, horn-shavings and coarse fish scraps	3
Phosphoric acid soluble in water	5½
" " " ammonia citrate	5
Insoluble phosphoric acid in mixed fertilizers	2
Phosphoric acid in fine bone and tankage	5
" " fine medium bone and tankage	4
" " medium bone and tankage	3
" " coarser bone and tankage	2
" " fine ground fish, cotton-seed meal, castor pomace and wood ashes	4½
Potash as high grade sulphate, ashes, etc., and in mixtures free from muriates or chlorides	5
Potash as muriate or in forms containing muriates or chlorides	4½
Organic nitrogen in feed stuffs	12
Phosphoric acids in feed stuffs	4½
Potash in feed stuffs	5

For an explanation of the method of calculating the commercial value, see BULLETIN 16, page 34.

Bulletin 40. October, 1896.

KINGSTON, RHODE ISLAND.

FERTILIZERS.

POTATO SCAB.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 40.

ANALYSES OF COMMERCIAL FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL, AND C. L. SARGENT.

This Bulletin, like Bulletin No. 39, contains the analyses of commercial fertilizers collected in the course of the official inspection for the year 1896. Those analyses not included in this and the former Bulletin will be published and issued soon.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
695	American Fert. Co.'s Alkali Nitrate Phosphate..	American Fert. Co., 153 Milk st., Boston..	M. Butler & Son, Newport.
567	Baker's Complete Grass Manure................	H. J. Baker & Bro., 93–97 William st., N.Y.	E. O. Easterbrooks, Warren.
597	Bowker's Farm and Garden Phosphate..........	Bowker Fert. Co., 43 Chatham st., Boston.	H. W. Partelow, Wakefield.
596	" Hill and Drill Phosphate.	Bowker Fert. Co., 43 Chatham st., Boston.	" " "
677	" Lawn and Garden Fertilizer..........	Bowker Fert. Co., 43 Chatham st., Boston	W. A. Potter & Co., Providence.
562	" Stockbridge Manure for Corn, Grain, etc	Bowker Fert. Co., 43 Chatham st., Boston.	Wardwell Lumber Co., Bristol.
571	" " " " Roots.........	Bowker Fert. Co., 43 Chatham st., Boston.	" " " "
573	" " " " Top Dressing..	Bowker Fert. Co., 43 Chatham st., Boston.	" " " "
641	" Sure Crop Phosphate.....	Bowker Fert. Co., 43 Chatham st., Boston.	T. B. Śegar, Hope Valley.
667	Bradley's Ammoniated Bone Phosphate.........	Bradley Fert. Co., State st., Boston.......	Halliday Bros., E. Providence.
566	" Complete Manure for Top Dressing. ..	Bradley Fert. Co., State st., Boston.	Seymour Bros., Warren.
592	" Original Coe's Superphosphate........	Bradley Fert. Co., State st., Boston......	J. C. Tucker, Jr., Wakefield.
577	" X. L. Superphosphate...............	Bradley Fert. Co., State st., Boston.......	Seymour Bros., Warren.
640	Brightman's Superphosphate...........	W. J. Brightman & Co., Tiverton, R. I ..	John E. Arnold, Wyoming.

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
695	American Fert. Co.'s Alkali Nitrate Phosphate	4.06	....	..	**4.06**	*4.00*	69	.80	14.89	**16.38**	*17 0*	**1.49**	.....	**.44**	[3]...	.24	*$18.89*
567	Baker's Complete Grass Manure	1.36	1.36	1 00	**3.72**	*3.71*	2.71	3.64	.97	**7.32**	.....	**6.35**	*5.0*	**7.85**	*7.5*	*	*24.63*
597	Bowker's Farm and Garden Phosphate	.51	....	1.43	**1.94**	*1 60*	3 95	4.43	3.47	**11.85**	*10 0*	**8.38**	*8.0*	**2.53**	*2.0*	*	*17.83*
596	Bowker's Hill and Drill Phosphate	.72	....	1.97	**2.69**	*2.50*	8.21	1 96	2.10	**12.27**	*12.0*	**10.17**	*9 0*	**2.48**	*2.0*	*	*21 52*
677	Bowker's Lawn and Garden Fertilizer	1.86	2.05	.52	**4.43**	*3.25*	1.50	3.24	4.09	**8.83**	*8 0*	**4.74**	*6.0*	**4.89**	*5 0*	*	*23.56*
562	Bowker's Stockbridge Manure for Corn, Grain, etc	1.42	....	2.10	**3.52**	*3.25*	8.00	2.14	2 47	**12.61**	*10.0*	**10.14**	*8 0*	**4.36**	*4.0*	*	*25.56*
571	Bowker's Stockbridge Manure for Roots	2.56	...	2.31	**4.87**	*2.50*	3.91	1.97	5 19	**11.07**	*10.0*	**5.88**	*7.0*	**6.31**	*4.0*	*	*27.41*
573	Bowker's Stockbridge Manure for Top Dressing	2.45	....	2.55	**5.00**	*5.00*	3.95	1.94	5.32	**11.21**	*6 0*	**5.89**	*4.0*	**5.93**	*6.0*	*	*27.52*
641	Bowker's Sure Crop Phosphate	.28	....	.82	**1.10**	*.75*	4.49	5 31	2.66	**12.46**	*10.0*	**9.80**	*8.0*	**1.32**	*1.0*	*	*15 56*
667	Bradley's Ammoniated Bone Phosphate	.44	....	1.53	**1.97**	*1.65*	7 15	2.14	2.42	**11.71**	*10.0*	**9.29**	*8.0*	**1.17**	*1.0*	*	*17 50*
566	Bradley's Complete Manure for Top Dressing	5.22	....	....	**5.22**	*4 95*	.96	4.30	1.76	**7.02**	*6.0*	**5.26**	*5.0*	**2.51**	*2.5*	.65	*22.57*
592	Bradley's Original Coe's Superphosphate	.38	...	1.86	**2.24**	*2.05*	4.65	4.28	2.37	**11.30**	*10.0*	**8.93**	*8.0*	**1.87**	*1.0*	*	*18.27*
577	Bradley's X. L. Superphosphate	.47	....	2.20	**2.67**	*2.50*	4.38	5.42	3 45	**13.25**	*11.0*	**9.80**	*9.0*	**2.25**	*2.0*	*	*21.08*
640	Brightman's Superphosphate	.90	...	1.69	**2.59**	*2.50*	2.37	5.18	2.40	**9.95**	*8 0*	**7.55**	*6.0*	**5.51**	*5.0*	*	*20.87*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.
[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.
[2] The schedule of prices used in estimating these values is to be found on page 68, Bulletin 39.
[3] There was no guaranty for potash, but 9 per cent. of "Alkali" were guaranteed.

Sample No.	NAME OF BRAND.	MANUFACTURER.	DEALER.
593	Church's Special Fertilizer, "B"	Daniel T. Church, Tiverton, R. I.	J. C. Tucker, Jr., Wakefield.
594	" Standard Fertilizer, "C"	" " " "	" " " "
628	Clark's Cove Fert. Co.'s Great Planet "A" Manure	Clark's Cove Fert. Co., State st., Boston	Chas. H. Ward, Middletown.
697	Cleveland Dryer Co.'s Superphosphate	Cleveland Dryer Co., Cleveland, O.	Lewis C. Grinnell, Kingston.
584	Coe's High Grade Ammoniated Bone Superphosphate	E. Frank Coe, 16 Burling Slip, New York.	Davis & Slocum, Lafayette.
659	Crocker's New Rival Ammoniated Superphosphate	Crocker Fert. and Chem. Co., Buffalo, N.Y.	R. F. Brooks, Harrisville.
588	Cumberland Superphosphate	Cumberland Bone-Phos. Co., Portland, Me.	F. W. Sherman, Bellville.
569	Darling's Animal Fertilizer	L. B. Darling Fert. Co., Pawtucket, R. I.	Seth Paull, Bristol.
645	" " " "G"	" " " " "	H. W. Potter, Riverpoint.
589	Great Eastern Vegetable, Vine and Tobacco Fertilizer	Great Eastern Fert. Co., Rutland, Vt.	J. V. Baker, Wickford.
682	Lowell Fert. Co.'s Animal Fertilizer	Lowell Fertilizer Co., Lowell, Mass.	Martin Bros., Barrington.
660	Mapes' Complete Manure, "A" Brand	Mapes Formula & Peruv. Guano Co., N.Y.	Capron Bros., Woonsocket.
575	" Corn Manure	" " " " "	Seymour Bros., Warren.
622	Mitchell's Complete Vegetable Fertilizer	Mitchell Fertilizer Co., Tremley, N. J.	Geo. A. Weaver Co., Newport.

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
593	Church's Special Fertilizer "B"	1 52	....	2.21	**3.73**	3.73	3.99	4.41	2.36	**10.76**	9.	**8.40**	8.	**5.18**	6.	*	$24.69
594	Church's Standard Fertilizer "C"......	.77	....	1.63	**2.40**	2.50	1.89	4.44	3.02	**9.35**	8	**6.33**	6.	**5.00**	5.	*	18.87
628	Clark's Cove Fert. Co.'s Great Planet "A" Manure.....................	1.92	....	1.59	**3.51**	3.50	3.86	4.08	1.45	**9.39**	9.	**7.94**	8.	**7.66**	7.	*	25.43
697	Cleveland Dryer Co 's Superphosphate.	.19	....	1 .90	**2.09**	2.05	5.05	4 08	2.41	**11.54**	11.	**9.13**	9.	**1.97**	2.	*	18.20
584	Coe's High Grade Ammoniated Bone Superphosphate..	.14	.31	1.72	**2.17**	2.00	7.24	1.86	3.00	**12.10**	11.	**9.10**	9.	**1.95**	1.85	trace	19.10
659	Crocker's New Rival Ammoniated Superphosphate.....................	....	....	1 43	**1.43**	1.20	7.13	2.97	3.49	**13.59**	11.	**10.10**	10.	**1.91**	1.6	*	17.93
588	Cumberland Superphosphate	.49	....	1.72	**2.21**	2 06	5 71	2.71	2.71	**11.13**	10.	**8.42**	8.	**2.08**	2.	*	18.08
569	Darling's Animal Fertilizer............	.12	....	3.08	**3.20**	3.00	2.23	4.90	5.94	**13.07**	10.	**7.13**	6.	**5.78**	4.	*	23.87
645	Darling's Animal Fertilizer "G".......	....	...	2.25	**2.25**	2.00	4.36	4 72	6.09	**15.17**	7	**9.08**	6	**4.14**	4.	*	21.99
589	Great Eastern Vegetable, Vine and Tobacco Fertilizer...................	.13	....	2 16	**2.29**	2.06	6.09	2.41	1.30	**9.80**	9.	**8.50**	8.	**6.03**	6.	*	21.46
682	Lowell Fert. Co.'s Animal Fertilizer...	.52	....	2 00	**2.52**	2 47	7.62	6.00	1.88	**15.50**	8	**13.62**	7.	**3.87**	4.	*	25.61
660	Mapes' Complete Manure, "A" Brand.	.75	.40	1.79	**2.94**	2.47	5.81	4.21	2.90	**12.92**	12.	**10.02**	10	**3.05**	2.5	*	22.75
575	Mapes' Corn Manure	.62	.32	1.55	**2.49**	2.47	5.69	2.92	2 67	**11.28**	10.	**8.61**	8.	**6.45**	6.	*	23.03
622	Mitchell's Complete Vegetable Fertilizer	1.69	....	2.20	**3.89**	3.00	4.99	3.02	1.33	**9.34**	9.	**8.01**	8.	**6.04**	6	4.10	25.26

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.
[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.
[2] The schedule of prices used in estimating these values is to be found in Bulletin 39, page 68.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
557	National Fert. Co.'s Chittenden's Market Garden Fertilizer	National Fert. Co., Bridgeport, Conn	F. D. Madison, East Greenwich.
637	Pacific Guano Co.'s High Grade General Fertilizer	Pacific Guano Co., Box 1368, Boston, Mass	A. P. Smith, Newport.
549	Parmenter & Polsey's Plymouth Rock Brand Fertilizer	Parmenter & Polsey, Peabody, Mass	W. G. Rose, Slocumville.
658	Quinnipiac Corn Manure	Quinnipiac Co., 92 State st., Boston	R. F. Brooks, Harrisville.
631	" Market Garden Manure	" " " "	Joshua Coggeshall, Middletown.
662	Read's Special Truck Manure	Read Fert. Co., New York.	D. C. Curtis, Apponaug.
671	" Vegetable and Vine Fertilizer	" " "	" " "
612	Russia Cement Co.'s Complete Manure for Corn, Grain and Grass.	Russia Cement Co., Gloucester, Mass	F. P. Babcock, Westerly.
638	Russia Cement Co.'s Essex H. G. Superphosphate.	" " " "	Richmond & Rogers, Hope Valley.
604	Sanderson's Formula "A"	Lucien Sanderson, New Haven, Conn	C. H. Knowles, Point Judith.
655	Standard Fert. Co.'s Standard Fertilizer	Standard Fertilizer Co., State st., Boston	J. O. Smith, Oakland.
656	Wilcox's Ammoniated Bone Superphosphate	Wilcox Fertilizer Co., Mystic, Conn	Hopkins & Hopkins, Oakland.
615	" Complete Bone Superphosphate	" " " " "	F. P. Babcock, Westerly.
644	Williams & Clark's Ammoniated Bone Superphosphate	Williams & Clark Fert. Co., 92 State st., Boston	H. W. Potter, Riverpoint.
646	Williams & Clark's Royal Bone Phosphate	Williams & Clark Fert. Co., 92 State st., Boston	" " "

Sample No.	Name of Brand.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
557	Nat. Fert. Co.'s Chittenden's Market Garden Fertilizer	....	....	2.50	**2.50**	*2.47*	.61	6.44	2.90	**9.95**	*9.0*	**7.05**	*7.0*	**6.82**	*6.0*	*	*$21.41*
637	Pacific Guano Co.'s High Grade General Fertilizer	1.75	....	1.73	**3.48**	*3.25*	3.85	4.58	1.70	**10.13**	*9.0*	**8.43**	*8.0*	**6.53**	*7.0*	*	*24.95*
549	Parmenter & Polsey's Plymouth Rock Brand Fertilizer	.41	.26	2.23	**2.90**	*2.88*	3.99	4.51	2 12	**10.62**	*9.0*	**8.50**	*8.0*	**6.12**	*4.0*	*	*23.39*
658	Quinnipiac Corn Manure	.53	....	1 98	**2.51**	*2.06*	3.94	5.07	2.99	**12.00**	*10.0*	**9.01**	*9.0*	**1.51**	*1.5*	*	*18.93*
631	Quinnipiac Market Garden Manure	1.84	....	1.67	**3.51**	*3.30*	4.00	4.56	1.65	**10.21**	*9.0*	**8.56**	*8.0*	**6.63**	*7.0*	*	*25.24*
662	Read's Special Truck Manure	.80	...	4.17	**4.97**	*4.94*	2 92	2.44	2.87	**8.23**	*6.0*	**5.36**	*5.0*	**5.30**	*5.0*	*	*25.41*
671	Read's Vegetable and Vine Fertilizer	.14	....	2.22	**2.36**	*1.65*	5.00	1.28	1.30	**7.58**	*7.0*	**6.28**	*6.0*	**8.50**	*8.0*	*	*21.55*
612	Russia Cement Co.'s Complete Manure for Corn, Grain and Grass	.98	....	3.33	**4.31**	*3.71*	4.27	2.48	3.38	**10.13**	*10.0*	**6.75**	*7.5*	**10.37**	*9.5*	*	*29.83*
638	Russia Cement Co.'s Essex High Grade Superphosphate	.46	....	2.38	**2.84**	*2.47*	1.71	5.72	6.46	**13.89**	*11.0*	**7.43**	*9.0*	**5.06**	*4.0*	*	*22.63*
604	Sanderson's Formula "A"	1.60	.25	1.83	**3.68**	*3.30*	4.49	3.14	2.16	**9.79**	*10.0*	**7.63**	*6.0*	**7.06**	*6.0*	*	*25.48*
655	Standard Fert. Co.'s Standard Fertilizer	.48	...	1.71	**2.19**	*2.00*	5.51	2.74	2.60	**10.85**	*10.0*	**8.25**	*8.0*	**2.09**	*2.0*	*	*17.81*
656	Wilcox's Ammoniated Bone Superphosphate	.27	.61	2.42	**3.30**	*2.50*	3.06	3.18	2.69	**8.93**	*7.0*	**6.24**	*6.0*	**5.79**	*5.0*	*	*22.18*
615	Wilcox's Complete Bone Superphosphate	.17	.38	1 97	**2.52**	*2.00*	4.84	3.57	2.07	**10.48**	*9.0*	**8.41**	*8.0*	**3.15**	*3.0*	*	*19.68*
644	Williams & Clark's Ammoniated Bone Superphosphate	.68	....	1.97	**2.65**	*2.47*	4.80	5.03	2.09	**11.92**	*10.0*	**9.83**	*9.0*	**2.00**	*2.0*	*	*20.31*
646	Williams & Clark's Royal Bone Phosphate	....	....	1.14	**1.14**	*1.03*	3 31	5.17	2.84	**11.32**	*8.0*	**8.48**	*7.0*	**2.02**	*2.0*	*	*14.96*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulphate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found on page 68, Bulletin 39.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
599	Bowker's Fresh Ground Bone	Bowker Fert. Co., 43 Chatham st., Boston.	H. W. Partelow, Wakefield.
650	" High Grade Sulphate of Potash	" " " " "	Hoxie Bros. Co., Phenix.
648	" Muriate of Potash	" " " " "	" " "
647	" Nitrate of Soda	" " " " "	" " "
669	Bradley's Muriate of Potash	Bradley Fert. Co., State st., Boston	Halliday Bros., E. Providence.
666	" Nitrate of Soda	" " " " "	" " "
560	Mapes' Pure Ground Bone (Dissolved in Sulphuric Acid)	Mapes Formula and Peruv. Guano Co., N. Y	Seymour Bros., Warren.
556	National Fert. Co.'s Chittenden's Dissolved Boneblack	National Fert. Co., Bridgeport, Conn	F. D. Madison, East Greenwich.
555	National Fert. Co.'s Chittenden's Muriate of Potash	" " " " "	" " " "
552	" " Dried Blood	" " " " "	" " " "
665	" " Kainit	" " " " "	Halliday Bros., E. Providence.
551	" " Nitrate of Soda	" " " " "	F. D. Madison, East Greenwich.
639	" " Sulphate of Potash	" " " " "	Richmond & Rogers, Hope Valley.
602	Sanderson's Dissolved Boneblack	Lucien Sanderson, New Haven, Conn	Chas. H. Knowles, Point Judith.
603	" Muriate of Potash	" " " "	" " "
601	" Nitrate of Soda	" " " "	" " "
606	" Sulphate of Potash	" " " "	" " "

Sample No.	Name of Brand.	Nitrogen. Nitrogen in nitrates.	Nitrogen in ammonia salts.	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Chlorine.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[1]
599	Bowker's Fresh Ground Bone	....	....	2.78	**2.78**	*2.50*	1.69	9.05	10 55	**21.29**	*18.00*	**10.74**	*5.*	....	....	....	*$22.91*
650	Bowker's High Grade Sulphate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**51.40**	*48.*	....	*51 40*
648	Bowker's Muriate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**48.87**	*50.*	....	*43.98*
647	Bowker's Nitrate of Soda	15.40	....	....	**15.40**	*15.67*	....	....	....	....	....	....	....	....	....	....	*41.58*
669	Bradley's Muriate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**50.64**	*50.55*	....	*45.58*
666	Bradley's Nitrate of Soda	15.57	....	....	**15.57**	*15.50*	....	....	....	....	....	....	....	....	....	....	*42.04*
560	Mapes' Pure Ground Bone (Diss. in Sulphuric Acid)	....	....	2.71	**2.71**	*2.06*	7.25	7.84	2.97	**18.06**	....	**15.09**	*12.*	....	....	....	*24.60*
556	National Fert. Co.'s Chittenden's Diss. Boneblack	....	....	....	....	....	14.10	1.49	.43	**16.02**	....	**15.59**	*16.*	....	....	....	*17.17*
555	National Fert. Co.'s Chittenden's Muriate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**46.46**	*50.55*	....	*41.81*
552	National Fert. Co.'s Dried Blood	....	....	13.69	**13.69**	*12.00*	....	....	....	....	....	....	....	....	....	....	*38.33*
665	National Fert. Co.'s Kainit	....	....	....	....	....	....	....	....	....	....	....	....	**12.79**	*12.*	....	*11.51*
551	Nat. Fert. Co.'s Nitrate of Soda	15.74	....	....	**15.74**	*15.67*	....	....	....	....	....	....	....	....	....	....	*42.50*
639	Nat. Fert. Co.'s Sulphate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**25.76**	*25.95*	1.92	*26.67*
602	Sanderson's Dissolved Boneblack	....	....	....	....	....	16.64	1.38	.29	**18.31**	*16.00*	**18.02**	....	....	....	....	*19.80*
603	Sanderson's Muriate of Potash	....	....	....	....	....	....	....	....	....	....	....	....	**54.26**	*50.55*	....	*48.83*
601	Sanderson's Nitrate of Soda	15.40	....	....	**15.40**	*15 67*	....	....	....	....	....	....	....	....	....	....	*41.58*
606	Sanderson's Sulphate of Potash	....	....	....	....		....	....	....	....	....	....	....	**28.41**	*27.03*	1.28	*28.24*

[1] The schedule of prices used in estimating these values is to be found in Bulletin 39, page 68.

POTATO SCAB.

H. J. WHEELER AND G. M. TUCKER.

THE EFFECT OF THE PRESENCE OF SODIUM CHLORID (COMMON SALT), SODIUM CARBONATE AND OXALIC ACID UPON THE DEVELOPMENT OF THE POTATO SCAB, WHEN TUBERS WERE GROWN WITH THE AID OF BARNYARD MANURE.

This experiment was conducted in the pots and soil which were used for the same purpose in 1894 and 1895, a description of which has been given elsewhere.[1] Barnyard manure which was fine and well mixed was employed as a fertilizer at the rate of four pounds per pot in 1894, three pounds per pot in 1895, and six pounds per pot in 1896. Where oxalic acid was used it was at the rate of 20 grams per pot in 1894 and 30 grams in 1895. The treatment with oxalic acid in 1896 was the same as in 1895, except that in addition to the 30 grams which were applied just before planting, each pot was watered July 13, about a week after the potatoes bloomed, with three quarts of water containing 100 cubic centimeters of a solution of oxalic acid prepared by dissolving 90 grams of the acid in 1 liter of water. Those pots to which oxalic acid was not applied were given at the same time a like quantity of water. The annual application of sodium chlorid (common salt) and sodium carbonate remained constant and amounted, where used, to 6.37 grams and 5.53 grams per pot respectively. The seed tubers of 1894 were but slightly scabbed, those of 1895 were practically covered with the scab, while those of 1896 were not only nearly free therefrom but were treated with a 1 to 1000 corrosive sublimate solution for one and one-half hours. The potato beetles were hand picked during each of the three years, and spraying to prevent the blight was not resorted to. By this means Bordeaux mixture and Paris green were kept away from the pots so that

[1] Bull. 30, R. I. Agrl. Expt. Station, 1894, p. 79.

the results obtained could not be influenced in the least by the presence of unequal amounts of these ingredients. The results obtained are embodied in the following table:

TABLE SHOWING THE INFLUENCE OF THE PRESENCE OF SODIUM CHLORID (COMMON SALT), SODIUM CARBONATE AND OXALIC ACID UPON THE DEVELOPMENT OF THE POTATO SCAB, WHEN TUBERS WERE GROWN WITH THE AID OF BARNYARD MANURE.

MATERIALS USED.	No. of pot.	No. of tubers free from scab.	No. of tubers scabbed.	No. of tubers badly scabbed.	Total No. of tubers.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Barnyard manure and common salt (sodium chlorid).	67	0	11	2	11	0.0	100.0	18.2
	68	2	12	2	14	14.3	85 7	28.6
	69	4	12	2	16	25 0	75.0	12 5
Barnyard manure.	82	0	16	7	16	0.0	100.0	43 8
	83	4	16	4	20	20.0	80.0	20 0
	84	0	22	9	22	0.0	100.0	40.9
Barnyard manure and sodium carbonate.	79	1	16	9	17	5.8	94.1	52.9
	80	1	22	11	23	4.3	95.7	47.8
	81	0	20	12	20	0.0	100.0	60.0
Barnyard manure, common salt and oxalic acid.	64	9	8	0	17	52.9	47.1	0.0
	65	5	11	1	16	31.3	68.7	6.3
	66	5	13	6	18	27 7	72 2	33 3
Barnyard manure and oxalic acid.	70	5	11	2	16	31.3	68.7	12.5
	*71	1	17	9	18	5.6	94 4	50.0
	72	2	14	3	16	12.5	87 5	12 5
Barnyard manure, sodium carbonate and oxalic acid.	76	7	24	2	31	22 6	77.4	64.5
	77	3	16	4	19	15.8	84.2	21 1
	78	2	11	8	13	15.4	84.6	61 5

*Badly attacked by wire worms and it is possible that some spots attributed to the scab fungus were caused by the worms.

It will be seen, as was the case in 1895, that there is in some cases considerable variation in the results from pots of the same group, yet they are perhaps as uniform as could be expected in view of the nature of the experiment. In order to better facilitate comparisons the averages for each group have been calculated from the foregoing table and are embodied in the following one:

TABLE SHOWING THE AVERAGE PERCENTAGES OF FREE, SCABBED AND BADLY SCABBED POTATO TUBERS, WHEN GROWN WITH THE AID OF BARNYARD MANURE FOR THE THIRD SEASON IN THE SAME SOIL, IN CONNECTION WITH OXALIC ACID AND SODIUM COMPOUNDS AS GIVEN IN THE LEFT HAND COLUMN.

[Scabbed untreated seed tubers were used in 1894 and 1895. Those used in 1896 were treated with a solution of corrosive sublimate, 1 to 1000, for one and one-half hours.]

OXALIC ACID AND SODIUM SALTS USED (CHEMICALLY PURE).	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Sodium chlorid (common salt).......	14.6	85.4	14.6
None............................	6.9	93.1	34.5
Sodium carbonate (soda ash).........	3.3	96 7	53 3
Oxalic acid and sodium chlorid (common salt)....	37.3	62.7	13.7
Oxalic acid*.........................	21 9	78.1	15 6
Oxalic acid and sodium carbonate....	19.0	80.9	22.2

Excluding from the average, pot 71, in the oxalic acid group, the results are, as seen by the forgoing table, fully in accord with those of 1895, namely, by the use of common salt there were fewer scabbed and badly scabbed tubers and a greater percentage free

*Average of pots 70 and 72. Pot 71 was omitted owing to the great probability that much of the injury there observed was attributable to wire worms instead of to the scab fungus. The averages, including pot 71, would have been as follows: per cent. free, 16; per cent. scabbed, 84; per cent. badly scabbed, 28.

from the scab than where barnyard manure was used alone. It will be seen on the contrary that by the use of sodium carbonate in connection with the barnyard manure the percentages of scabbed and badly scabbed tubers were increased. Sodium chlorid (common salt) and oxalic acid used together were more effective in lessening the scab than either when used alone, while on the contrary sodium carbonate in the same connection seemed to have lessened the otherwise beneficial effects from the use of oxalic acid. The lessening of the scab by the use of oxalic acid in 1894 and 1895, lends further probability to the idea that the cause for immunity from the scab on our soil even where badly scabbed seed tubers are used is attributable either to its acidity directly or to the absence of carbonates in the soil. If carbonates were present in considerable quantity the soil could not be acid, so that the marked acidity of a soil seems to afford assurance of practical immunity from the potato scab.

THE EFFECT OF VARIOUS COMPOUNDS OF LIME UPON THE DEVELOPMENT OF THE POTATO SCAB, AND OBSERVATIONS UPON THE EFFECTIVENESS OF FLOWERS OF SULFUR AS A PREVENTIVE OF THE DISEASE UPON BADLY CONTAMINATED SOIL.

The pots and soil employed in this experiment are the same as were used in the experiments with lime compounds conducted in 1894 and 1895.[1] Untreated seed tubers were used the first two years of the trial, those in 1894 being slightly and those in 1895 badly scabbed.[2] The seed tubers employed in 1896 were almost if not wholly free from the scab and were treated for 1½ hours before cutting, with a solution of corrosive sublimate containing 1 part of corrosive sublimate to 1000 parts of water. The kinds and amounts of the various fertilizing materials used per pot in each of the three years of the experiment were as follows:

	1894. grms.	1895. grms.	1896. grms.
Dried Blood	21	20	20
Nitrate of Soda (commercial)	5	7	7
Muriate of Potash	10	10	10
Dissolved bone-black	25	25	25

[1] See Bull. 33, R. I. Agrl. Exp. Sta., Oct., 1895, p. 72.
[2] Ibid, p. 73, Fig. 2.

Those pots which received lime compounds at any time during the experiment were given applications in the several forms in 1894 at a rate equivalent in actual lime to $2\frac{1}{2}$ tons of air-slacked lime per acre, and in 1895 at a rate equivalent to half a ton per acre. No further applications of lime compounds were made in 1896 so that the results observed are attributable to the after effect of the two previous applications. The seed tubers used in 1896 were free or nearly free from scab germs for the reason that they were but slightly if at all scabbed and had been treated with a 1 to 1000 corrosive sublimate solution for one and a half hours and in consequence the results show the natural outcome of employing even treated seed tubers, upon a contaminated soil which is highly favorable to the development of the disease. They illustrate also that from untreated seed tubers upon a soil which is sour or deficient in carbonates, crops practically free from the scab may be grown.

From the following table it will be seen that calcium chlorid exerted, even though applied a year and two years previously, a poisonous action upon the potato plants, and that calcium sulfate (land plaster or gypsum) was the only form of lime employed which did not hinder the growth in a marked degree and at the same time permit of the production of tubers practically free from the scab.

TABLE SHOWING THE EFFECT OF VARIOUS COMPOUNDS OF LIME UPON THE DEVELOPMENT OF THE POTATO SCAB.

(See Figs. 1, 2, 3 and 4.)

[Each pot received the same amount of fertilizer, composed of dissolved boneblack, muriate of potash, nitrate of soda, and dried blood. Lime where used was employed in 1894 at the rate of 2½ tons of air-slacked lime per acre, and in 1895 at the rate of ½ ton per acre, none having been applied in 1896. The pots receiving calcium compounds were given quantities containing the same amount of calcium, irrespective of its form.]

No Lime was applied in 1896, and below are shown the forms employed in 1894 and 1895:	No. of pot.	No. of tubers free from scab.	No. of tubers scabbed.	No. of tubers badly scabbed.	Total No. of tubers.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Air-slacked Lime....	29	0	18	17	18	0.0	100.0	94.4
	30	0	19	19	19	0.0	100 0	100.0
	31†	6	10	7	16	37 5	62 5	43 8
Unlimed............	34	12	0	0	12	100.0	0.0	0.0
	35	12	0	0	12	100 0	0.0	0.0
	36†	2	0	0	2	100 0	0 0	0.0
Calcium chlorid*...	39	3	0	0	3	100.0	0.0	0.0
	40	2	0	0	2	100.0	0.0	0.0
	41†	2	0	0	2	100.0	0.0	0.0
Calcium sulfate*... (Plaster or Gypsum.)	44	10	1	0	11	90.9	9.1	0.0
	45	6	0	0	6	100.0	0.0	0.0
	46†	6	0	0	6	100 0	0 0	0 0
Calcium carbonate*.	49	0	11	11	11	0.0	100.0	100.0
	50	0	20	20	20	0.0	100.0	100 0
	51†	0	9	8	9	0.0	100.0	88 9
Calcium oxalate*...	61	0	16	16	16	0.0	100.0	100.0
	62	0	15	15	15	0 0	100 0	100 0
	63†	0	16	16	16	0.0	100.0	100.0
Calcium acetate*....	74†	0	15	15	15	0.0	100.0	100 0
	75	0	20	20	20	0.0	100.0	100.0
Wood ashes.........	28†	0	17	15	17	0.0	100 0	88.2
	73	0	13	13	13	0 0	100.0	100.0

* Chemically pure. † Flowers of sulfur mixed thoroughly with the upper 7 to 8 inches of the soil at the time of planting, at the rate of 600 pounds per acre.

In the case of wood ashes and air-slacked lime, the lime either is already, or passes rapidly in the soil into the form known as calcium carbonate (carbonate of lime); the same is probably true of the calcium oxalate and acetate when they are exposed to the decomposing agencies of the soil, and it is interesting to note that all of these compounds exerted an effect analogous to that of calcium carbonate, not only in favoring the growth of the potato plant but also upon the development of the scab disease upon the growing tubers. In striking contrast it will be seen that lime when combined with hydrochloric (muriatic) acid, i. e. in the form of calcium chlorid, furnished absolute immunity from the scab but almost destroyed the potato plants as well. Lime combined with sulfuric acid, that is, land plaster (gypsum) does not appear to have promoted the scab, or, at least, if the amount of scab present in one of the land plaster pots was attributable to the plaster, it was nevertheless not sufficient to do any practical damage. The yield may have been influenced unfavorably, though the fact that but three pots were employed in any case would preclude one, in consequence of the few data, from drawing a positive conclusion.[1]

The following table of averages calculated from the foregoing table renders the comparison of the effect of the various lime compounds more easy:

TABLE SHOWING THE AVERAGE PERCENTAGES OF FREE, SCABBED, AND BADLY SCABBED POTATO TUBERS, AS CALCULATED FROM THE FOREGOING TABLE.

[Potatoes were grown in the same soil in 1894 and 1895, from scabbed untreated seed tubers, while in 1896 smooth tubers treated 1½ hours with corrosive sublimate solution (1:1000) were employed.]

(Calculated from the foregoing table.)

Forms of lime used.	Per cent. free.	Per cent. scabbed.	Per cent. badly scabbed.
Air-slacked lime	11.3	88.7	81.1
No lime	100.0	0.0	0.0
Calcium chlorid	100 0	0.0	0.0
Calcium sulfate (plaster or gypsum)	95.7	4.3	0.0
Calcium carbonate	0.0	100.0	97.5
Calcium oxalate	0.0	100.0	100.0
Calcium acetate	0.0	100.0	100.0
Wood ashes	0.0	100.0	93.3

[1] The average yield of tubers per pot was 179.2 grms. in the case of the unlimed pots, and 126 2 in case of those receiving land plaster. In the case of calcium chlorid the average was but 35.2 grms. while where the other forms of lime were used it ranged from 489.8 to 563.8 grms.

From an examination of the table on page 85 it will be seen that reference is made therein to results secured by mixing flowers of sulur at a rate of 600 pounds per acre, with the upper 7 to 8 inches of surface soil at the time of planting. Owing to the fact that the soil of these pots had been badly contaminated by the use of scabbed seed tubers and by growing scabbed crops for two consecutive years, ideal conditions existed for submitting the sulfur treatment of the soil[1] to a most severe test. In Halsted's experiments at Freehold, N. J., he dealt with a soil which he supposed to have been badly contaminated with scab germs at the outstart. Trials were made of various substances as follows: lime 75, 150 and 300 bushels per acre; flowers of sulphur 150, 300 and 600 pounds per acre; manure in full, half and quarter applications (the absolute amounts are not given); corrosive sublimate 30, 60 and 120 pounds per acre; kainit 750, 1500 and 3000 pounds per acre and sulfate of copper (blue vitirol) at the rate of 75, 150 and 300 pounds per acre. One series of plots was untreated and in another the substances above enumerated were each tried as follows: the manure was applied in the hill, the seed tubers were rolled in the sulfur and in the lime and soaked in solutions[2] of corrosive sublimate, kainit and sulfate of copper in the case of the respective plots. Halsted states that the full and half applications (excepting the manure) were too strong and that the stand of plants was much reduced thereby. In relation to the quarter applications he states that "the stand was practically normal except in the sulfate of copper plot." Yet upon making a comparison of *yields* it appears that upon the check plot was 4½ bushels, while upon the plots with the quarter applications of sulfur, kainit and corrosive sublimate the yields were 3½, 3 and 2½ bushels respectively, so that even though the stand of plants was normal these substances appear in even quarter applications to have reduced the yield which is the chief factor aside from the amount of scab.

In his experiment upon the College farm, lime, gas-lime, kainit and wood ashes were tried in three amounts each and also the treatment of the seed tubers with corrosive sublimate solution of various strengths. Corrosive sublimate, cupram (ammoniacal carbonate of copper) and Bordeaux mixture were each applied to

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[1] B. D. Halsted, Bull. 112, New Jersey Agrl. Expt. Sta., 1895.

[2] The strength of the solutions employed is unfortunately omitted.

the soil[1] at the rate of 36 gallons per acre. Sulfur was also applied to the soil at the rate of 300 pounds per acre, the freshly cut seed tubers being rolled in it, after which the balance of the powder was "dusted in the open rows." Check sections were left without treatment. The seed tubers employed in all of the cases were scabbed but not badly. In this experiment applications of kainit to the soil failed to effect a decrease in the amount of scab, while in the Freehold experiment the germicidal action of the kainit seemed to be great and approximated closely that of the corrosive sublimate, sulfur and copper sulfate. Halsted fails, however, to call attention to this discrepancy in the results with kainit upon the two fields, and offers no explanation therefor. It seems probable that a difference in the alkalinity or acidity of the two soils may have been accountable for the variation in the results. Had the soil at New Brunswick been more alkaline than the other, or contained more carbonates, which seems probable from the relative amount of scab in each where the seed tubers were treated with corrosive sublimate, then it is possible that despite the tendency of the kainit to increase the acidity of the soil by which an indirect germicidal action may have been exerted at Freehold, the amounts used were totally inadequate to produce such a result in the more basic soil of New Brunswick. Assuming that the copper sulfate, Bordeaux mixture, cupram and corrosive sublimate exerted directly a germicidal action and not indirectly as the kainit may have done, then there is no cause for surprise that those substances showed less difference in their action. That such a conclusion in regard to the action of the kainit is justifiable seems probable in view of the results secured at this Station with air-slacked lime, land plaster and other materials. In these it was shown that common salt tended to decrease the amount of scab on limed soils while sodium carbonate increased it, and likewise under the same soil conditions, where ammonium sulfate produced less scab than the same amount of nitrogen in form of sodium nitrate, the former of which is acid and the latter basic in its tendency. In the experiment at Freehold as well as in that at New Brunswick sulfur gave as claimed by Halsted apparently good results, both as concerned treatment of the "seed" and soil treatment. In the experiment at Freehold the seed tubers

[1] It is impossible to conclude how these applications were made, though presumably the solutions were sprayed in the furrow in order to approximate as closely as possible the treatment with sulfur.

were not only scabbed but land was selected which had (as we infer from Halsted's statements) produced scabbed tubers previously. At New Brunswick it was not known that the scab fungus pre-existed in the field and the seed tubers were like those used at Freehold. In view of the fact that many farmers would like to grow potatoes upon soil known to be already contaminated, provided a means were found to prevent injury from the scab, the condition existing in our large experiment pots, viz: that of excessive contamination of the soil, furnished a most excellent opportunity for giving sulfur a good test. The results obtained at this Station and elsewhere in the past have shown the uselessness of Bolley's corrosive sublimate treatment in case the soil has been badly contaminated *and its conditions are favorable to the growth of the fungus.* The great effectiveness and value of the treatment is on the other hand highly manifest, the first season particularly, where the seed tubers are contaminated, and where the soil though uncontaminated is favorable to the propagation of the scab fungus. The only advantage so far as seed treatment alone is concerned which sulfur would seem to afford under the last-mentioned circumstances, at least with seed tubers practically free from scab, is greater ease of treatment and avoidance of the use of a dangerous poison. The most important point which seemed to be gained by Halsted was the successful use of sulfur as a treatment for *contaminated soils.*

It now remains to consider our own results.

Results from the Use of Sulfur as a Preventive of Potato Scab on a Badly Contaminated Soil.

It seems desirable at the outstart to call attention once more to the fact that Halsted, in the experiments above cited, does not mention in what manner the sulfur was applied to the soil in the experiment at Freehold, i. e., whether it was spread broadcast and harrowed in, or applied in the hill and drill, or in some other way. In the New Brunswick experiment it is definitely stated that the seed tubers were rolled in the sulfur and that the balance of the amount used, viz., 300 pounds per acre, was dusted in the open rows. The soil in certain of the pots in which our experiment was conducted was known positively to be badly contaminated, and owing to the successive production of two scabbed crops from scabbed seed tubers, the complete contamination of the entire sur-

face soil seemed fully assured. It seemed, therefore, best in testing the sulfur as to its germicidal action in the soil, to mix it as thoroughly as possible with the upper seven to eight inches in order to give it a fair trial. In view of its being mixed with this mass of soil, 600 pounds per acre were employed, which was double the quantity used by Halsted in the New Brunswick experiment. The seed tubers employed in this experiment, unlike those used in the two previous years, were almost, if not wholly, free from scab, and to insure still greater freedom from contamination through the seed tubers, these were treated for 1½ hours with a solution of corrosive sublimate containing one part of corrosive sublimate to one thousand parts of water. Owing to this precaution, the major part of the scab appearing on the crop was probably attributable to the scab fungus pre-existing in the soil, which, despite the presence of the sulfur, was capable of working injury. The data secured are to be found in the table on page 85. In connection with the air-slacked lime pots, the two without sulfur show each 100 per cent. of scab, and of badly scabbed tubers 100 and 94.4 per cent., while the pot which received sulfur had 37.5 per cent. free from scab, 62.5 per cent. scabbed, and only 43.8 per cent. badly scabbed. In the case of the calcium chlorid and unlimed pots all of the tubers were free from scab. The results upon the unlimed pots show conclusively that by the use of ordinary fertilizer our soil in its natural condition, i. e., when not treated with barn-yard manure, alkaline substances and carbonates of lime, magnesia, soda and potash, is destructive to the scab fungus, for had such not been the case, some scab must have resulted in 1896 in consequence of the use of scabbed seed tubers the two previous seasons. Where calcium sulfate (land plaster or gypsum) was used, one pot showed 9.1 per cent. of slightly scabbed tubers, with none badly scabbed, while the other untreated pot and that which received sulfur yielded a scabless product. In the case of calcium carbonate all of the tubers from the pots not treated with sulfur were badly scabbed. In the treated pot all of the tubers were scabbed, but only 88.9 per cent. were badly scabbed. In connection with calcium oxalate and calcium acetate, no benefit from the use of sulfur was apparent, since every one of the eighty-two tubers in the five pots was badly scabbed and totally unfit, for this reason, for market purposes. Where wood ashes were employed the tubers in the untreated pot were all badly scabbed. In that treated with sulfur all of the

tubers were scabbed, and 88.2 per cent. were so badly scabbed as to render them unmerchantable. The results show in the most striking manner that though there may have been, and doubtless was, some advantage from the use of sulfur, yet in this instance, in a soil badly contaminated at the outstart, sulfur at the rate of even 600 pounds per acre applied by mixing it thoroughly with the upper seven to eight inches of soil, was of little practical value as a preventive of the potato scab. Had the sulfur been mixed only with the soil immediately about the potato tubers, as might be done (though at considerable expense) in field culture, the results from its use, so far as the scab was concerned, would doubtless have been better, though the yield might have been lowered. Even if applied in the hill or drill *without mixing with the soil* many of the newly formed tubers would be so located as not to come in immediate contact with it, and would presumably not be benefited in a marked degree. Since the pots in which the experiment was conducted were but eighteen inches in diameter, and owing to the fact that not infrequently some of the new tubers have been formed not far from the outer edge of the pot, the plan of mixing the sulfur with the soil (in view of the fact that double the amount was used which Halsted found effective in the manner in which he employed it) would not seem to be open to objection. In fact it seemed reasonable in view of the double amount of sulfur employed and *on account of the thorough distribution of the scab-fungus in the soil* to expect its efficiency to be as great or greater than that of half the quantity if dusted upon the soil about the seed tubers before covering them. The seed tubers were not rolled in sulfur for the reason that they had first been treated with corrosive sublimate solution.

In view of the fact that in practically all of the experiments made elsewhere as well as in our own, and particularly in that reported in the table on page 85, no benefit from treatment of the seed tubers with corrosive sublimate is observable where much contamination has already resulted and the soil is favorable to the disease, it is evident that little or no previous contamination of the soil at Freehold existed, for otherwise *a treament of the seed tubers only* with corrosive sublimate could not have reduced the scab to 1 per cent., the amount found by Halsted. It is evident therefore that all of the substances which were preventives of scab in that case, were so perhaps wholly by virtue of their having destroyed the germs on the seed tubers, and not in any consider-

able degree on account of their destruction of germs preëxisting in the soil, as supposed by Halsted. It would be illogical of course to treat the soil if it were not already contaminated, for it would be simpler and less expensive to treat the seed tubers in such a case. It appears probable that Halsted supposed even at the end of his experiment that the soil at Freehold needed treatment, for he says, "Taking the whole acre of experiments and combining soil with seed treatment the best results as a remedy for the scab were obtained by sulfur, followed by kainit and corrosive sublimate respectively." In fact no conclusions could legitimately have been drawn from this experiment as to the effectiveness of any of the materials as remedies for contaminated soils, because his own results show that little or no contamination apparently existed.

In Halsted's New Brunswick experiment a soil was selected which had been used the previous season for experiments upon the club-root of cabbages and *it was one in which the scab fungus was not known to be present.* Tubers somewhat scabbed and of the same kind as those used at Freehold were employed.

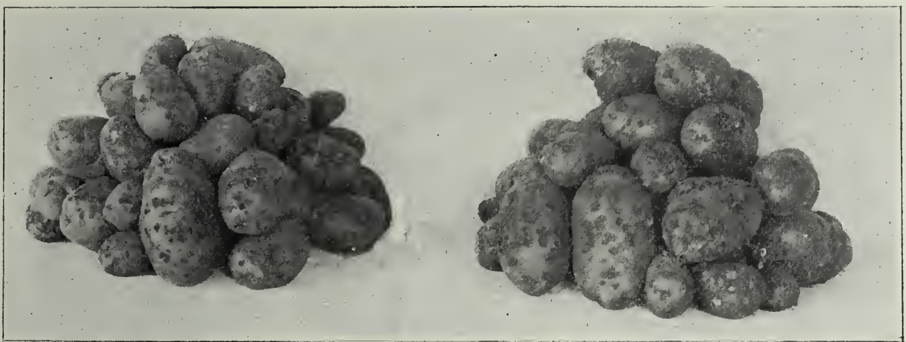
In connection with gas-lime, kainit and wood ashes, there was 100 per cent. of scab in each instance; the same was true likewise where the seed tubers were soaked in corrosive sublimate. In one of the check rows 97 per cent. of the tubers were scabbed, and on that having the smallest amount of lime 98 per cent. were affected. Corrosive sublimate, Bordeaux mixture and cupram (solutions) applied to the soil in some manner unmentioned by the author, reduced the scab from 100 to 70 or 80 per cent. Where the seed tubers were rolled in sulfur and the balance of the 300 pounds per acre dusted in the rows, there was but 5 per cent. of scab. Where the corrosive sublimate treatment of the seed tubers was resorted to, 100 per cent. of scab resulted. In view of the fact that some scab germs may escape destruction even when contaminated tubers which are themselves free or practically free from the scab are used, and where the treatment is continued as recommended by Bolley, viz., for an hour and a half, it would not be surprising if on the *scabbed tubers* employed by Halsted a considerable number of undestroyed germs existed after the treatment with corrosive sublimate solution for one hour, and the fact that 100 per cent. of scab was noticed in those cases, furnished no proof that the soil was originally contaminated with the fungus, for the entire amount may have been caused by undestroyed germs intro-

FIG. 1.

Air-Slacked Lime. Unlimed.

FIG. 2.

Calcium Sulphate.—(Plaster or Gypsum.) Calcium Chlorid.



Calcium Carbonate. FIG. 3. Calcium Oxalate.

Calcium Acetate. FIG. 4. Wood Ashes.

duced on the seed tubers. Accordingly, in this experiment as well as in that at Freehold, there seems to be no logical ground for the conclusion that sulfur had been an effective remedy for soils already contaminated. It might be objected that the failure of the corrosive sublimate treatment to reduce the scab at New Brunswick in the same degree that it did at Freehold was evidence of preëxisting contamination in the case of the former soil, but in view of the fact that the character of the soil exerts such a wonderful effect upon the virulence of the disease when contamination even in a slight degree has once resulted, it must be obvious that such an objection would be groundless. The only conclusion justifiable under the circumstances is that the soil at New Brunswick was probably more favorable as a medium for the propagation of the scab fungus than that at Freehold, but whether the former was or was not contaminated at the outstart cannot be definitely determined from the data at hand. It does not seem, therefore, that Halsted's experiments justify in any degree a conclusion as to the effectiveness of sulfur as a treatment for contaminated soils. In the experiment at Freehold there was no apparent advantage from its use over that of treating the seed tubers with corrosive sublimate except the avoidance of the use of a dangerous poison, for it must cost more for labor to roll the seed tubers in sulfur and sprinkle the powder in rows than to treat the "seed" with corrosive sublimate solution, and furthermore the greater expense of the 300 pounds of sulfur per acre is no unimportant factor when potatoes are grown at their present small margin of profit. In the New Brunswick soil which seemed to be favorable to the scab, the sulfur treatment as used, showed in the single test better results than corrosive sublimate, so that really the only legitimate claims for sulfur are based upon the results upon but one plot at New Brunswick, and even then in a trial against corrosive sublimate in which the time of treatment was not so long as recommended by Bolley and where the amount and manner of application of the sulfur were such as to make it quite an item of expense.[1]

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[1] In the Freehold experiment, where the seed tubers were rolled in sulfur (and presumably none dusted in the rows), there was 5 per cent. of scab against 1 per cent. where treatment with corrosive sublimate was employed. In view, therefore, of the fact that where the soil is favorable to the disease, the treatment of seed tubers is most necessary, and in remembrance of the danger of allowing even a little contamination to result in such cases, the results are more favorable to corrosive sublimate treatment than to the use of sulfur in that way.

The results at this Station as herein enumerated were obtained upon a soil known not only to have been contaminated but also to be favorable to the disease. This was therefore a trial of sulfur as a remedy for a contaminated soil by working it at the rate of 600 pounds per acre into the upper 7 to 8 inches of soil in a thorough manner. Of this treatment, it may be said to have been probably of some value, yet the crop was nevertheless practically spoiled by scab and in two instances no benefit was observable from its use. Had the sulfur been sufficiently effective to produce a merchantable crop under the conditions of the trial then there would have been a fairer prospect of some material advantage from its use on such soils under the conditions requisite in field culture, such for example as the broadcasting of sulfur or its use in the drill, though of course the matter of expense would be great unless a small quantity were found to be effective. It appears certainly that if when applied in this way it was not effective, then much smaller quantities broadcasted and even very much smaller quantities in the drill would prove of little or no value.

SUMMARY.

1. The results from the use of sodium compounds and oxalic acid in connection with barnyard manure confirm those obtained in 1895, viz.: common salt (sodium chlorid) tends to lessen the amount of scab. Soda ash (sodium carbonate) tends to increase the scab. Oxalic acid tends to lessen the scab when used with barnyard manure only or when common salt or soda ash is present.

2. The results with calcium compounds also accord closely with those of 1894 and 1895. A scabless product was produced where calcium chlorid or land plaster (gypsum) was used. Calcium chlorid had a marked poisonous effect upon the potato plants and nearly destoyed them. Land plaster appeared not to have increased, and it may have lessened, the yield slightly. Where calcium at the same rate as in the calcium chlorid and land plaster was applied in the form of wood ashes, air-slacked lime, calcium carbonate, calcium oxalate and calcium acetate, the vigor of the plants and the yield of tubers were wonderfully increased, but the crop was so badly scabbed as to be worthless.

3. Where the fertilizer (see page 85) was used without any

lime compounds no scab resulted, showing that the acid soil must have rendered dormant or destroyed the scab fungus introduced on the scabbed seed tubers of the two previous years.

4. The treatment of the seed tubers with a 1 to 1000 solution of corrosive sublimate for one and one-half hours was utterly useless where the soil was favorable to the disease and where it was already badly contaminated by two preceding lots of scabbed seed tubers and scabbed crops. In other experiments by us heretofore where the soil was favorable to the disease, but where little or no contamination already existed, Bolley's corrosive sublimate treatment proved highly effective. It is probable that some germs escape even this treatment, but fewer, of course, where the seed tubers are not scabbed, so that there is danger if potatoes and root crops are grown frequently that serious contamination may nevertheless result eventually. The necessity, on land intended for potato growing, of avoiding the frequent use of fertilizers which tend to make the soil more favorable to the development of the scab fungus is therefore obvious.

5. The materials which favor the scab and which are at times applied to land are: stable manure of all kinds, wood ashes, air-slacked or caustic lime and carbonates of soda (soda ash), potash, lime and magnesia.

6. The materials which do not tend to make the scab worse and which may decrease it, are, most commercial fertilizers, seaweed potash salts, (excepting potassium carbonate) land plaster, common salt and ammonium sulfate. Sodium nitrate (Chili saltpeter) if used in large quantities may favor the scab eventually but from the amounts usually applied no serious results would be expected to follow. In case a soil were badly contaminated and favorable to the disease, superphosphate, ammonium sulfate, kainit, sulfate and muriate of potash are materials which, applied as fertilizers, would tend gradually to alleviate the conditions.

7. Sulfur (the remedy proposed by Halsted) when mixed thoroughly with the upper seven to eight inches of a badly contaminated soil favorable to the disease, though checking the scab somewhat, was practically useless.

8. The treatment of seed tubers by rolling in sulfur and sprinkling the balance in the row at the rate of 300 pounds per acre is claimed by Halsted to be quite effective. The use of the

very poisonous corrosive sublimate solution would be thereby avoided, yet the additional expense of the sulfur over the corrosive sublimate treatment for this purpose militates against its use in that way where potatoes are grown at the present low prices.

9. The marked acidity (sourness) of soils, or the absence of carbonates in them seems to indicate their ability to produce a scabless product even when untreated seed tubers are used.

Bulletin 41. November, 1896.

KINGSTON, RHODE ISLAND.

SPINACH.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 41.

SPINACH CULTURE IN RHODE ISLAND.

L. F. KINNEY.

The object sought in cultivating plants is usually to produce a growth in some of their parts that is unnatural to the species in its native habitat. This part may be the flower, the seed, the fruit, the stem, or as in the case of spinach it happens to be the leaves. For generations gardeners have been constantly encouraging spinach plants to sport in their leaf growth, to depart from the habits of their ancestors and ever produce leaves with more cellular substance and less fibrous matter. As a result of such treatment we have as the spinach of the present time a very fickle plant, a plant that responds to slight impulses in a manner that is quite remarkable, but one that is very useful when properly managed. As a field crop it is capable of transforming earthy matters into a form that is palatable when cooked, in an exceedingly short time; furthermore it is capable of doing this at seasons of the year when it does not interfere with the growth of other crops upon the same land. Spinach is peculiar also in that practically all of the early growth of the plant excepting the root, is edible, no preliminary growth being necessary with this as is the case with many other plants before the marketable portion begins to form. This is a matter of considerable importance to producers who hold their crops to strict account for the moneys that are expended upon them. Spinach is a bulky but not a heavy vegetable to handle. It is extensively grown in Rhode Island. Besides what is used here hundreds and often thousands of barrels are shipped annually to other markets. It may yield as high as from five hundred to

one thousand bushels as a merchantable product per acre within eight weeks time after the seed is planted, and the price per bushel often equals that of potatoes, although the average price at which the crop is sold is probably considerably less. Taking one season with another spinach is regarded by growers who have not given its cultivation special attention as a difficult crop to secure. Still there is no insurmountable barrier in the way of anyone who may wish to grow it either as a spring or fall crop. It is not however perfectly hardy and there is always additional risk in wintering it out of doors even if it is handled in the most skillful manner. Doubtless a large proportion of the futile attempts to cultivate this vegetable in the smaller gardens in Rhode Island are attributable to a few common causes, which it is the object of this bulletin to point out, and to show, as far as known, ways of avoiding them. The observations which form the basis of this matter were made upon spring sown spinach.

SPINDLING.

The complaint is often made by gardeners who are not expert cultivators of spinach, that their plants do not form large and thick leaves but begin to spindle up at a very early age, and that the longer the crop remains in the field after this occurs the less valuable it becomes. This is a trouble that is traceable directly to unskillful culture and one that may be avoided by observing proper precautions; it is but the manifestation of a natural trait of the spinach plant, a striking back to its original habits before these were modified by cultivation. It should not be forgotten that spinach leaves as they appear under the influences of high cultivation, are made up largely of an unnatural growth; they are fattened by high feeding to satisfy the demand of the market. The modern varieties have become so accustomed to growing in soil that has been liberally supplied with everything that the roots need that they are unable to fully develop in soil of moderate fertility. The base leaves of spinach, which constitute the marketable portion of the plant, are few in number but they have acquired the habit of expanding in a remarkable fashion. They appear to be made up of cells which possess the power of indefinite division just as long as the protoplasm in them is highly nourished and while this growth goes on there is little danger of the plants spindling up prematurely. If, however, the roots at

any time become unable to furnish the substances which are needed to maintain the activity of these cells, then the soft cellular substance of the leaves begins to break down, and the

FIG. 1. A SPINDLE.

central stalk starts immediately whatever the age or size of the plant. To be sure there is a slight variation with different varieties in this respect; the slower growing kinds will stand a little longer than those that grow more rapidly but after all there is only a shade of difference. All of them will spindle up prematurely if improperly nourished but with a soil in suitable condition for the growth of this crop we believe that this trouble need not cause gardeners any serious anxiety.

When it is desirable to prolong the cutting for several weeks from a single sowing of seed it can be done by repeated thinning the plants and not allowing them to crowd at any time. They may stand close together and it is a fact that they seem to grow

best when the leaves nearly cover the ground, but as spinach is usually sown with from ten to twenty seeds per foot of drill the plants do not reach the largest size unless they are thinned.

FIG. 2. A fattened Spinach Plant less than eight weeks old.
The half-bushel measure is inverted over it to convey an impression of the size of the plant.

CLASSIFICATION OF VARIETIES.

Last spring spinach seed was sown at this station that was obtained from seed dealers in the United States and Canada under thirty-six different names, and it is supposed that the most of the varieties of this vegetable which are at present offered for sale in this country are included in this collection. So far as we have been able to learn, all of the varieties of the true spinach that are now grown have originated from a single natural species, viz., *Spinacia oleracea.* Besides the true spinach there is the New Zealand spinach, *Tetragonia expansa*, of which we have seen but a single kind, and the mountain spinach, *Atriplex hortensis*, which appears to have little to recommend its cultivation in New England.

It is hardly necessary to state that when we compared the plants in our trial plot we did not find as many distinct kinds as there were names upon our list. Still there were several types which had more or less definite characteristics, and perhaps we cannot express the results of our observations concerning the affinities of the different varieties better than by separating them into groups according to their resemblance to one or another type. There

FIG. 3. Where the varieties were compared.

being no authentic description accessible of several of the varieties included in the collection, attention is here called to the fact that where there was no proof to the contrary, it has been assumed that the seed which we received was properly named. Where practicable, plants from several duplicate lots of seed, of the same variety but obtained from different parties, were compared, but in a few cases varieties were represented by a single sample of seed.

GROUP I.—NORFOLK OR BLOOMSDALE SPINACH.

Plants more or less vase-form, leaves broad, thick and supported by their stalks so that they do not naturally rest upon the ground. Blossom stalks appear at an early age.

Varieties : American Curled,
Bloomsdale,
Bloomsdale Savoy Leaved,
Bloomsdale (American grown),
Norfolk,
Norfolk Savoy Leaved,
Round Seeded Savoy.

No important difference between these varieties could be detected as they were grown in the trial plot.

All the names appear to be synonymous with that at the head of the group.

This type of spinach is not popular among large growers in this State, although if well grown and harvested at just the right time it is unsurpassed in quality by any other variety.

FIG. 4. Norfolk, often called Savoy-leaved Spinach.

Plant fifteen inches across.

GROUP II.—ROUND LEAVED SPINACH.

Plants compact in habit of growth, with leaves conspicuously rounded in outline and formed close to the ground. Tissue firm, color dark green, blossom stalks formed rather tardily. A slow-growing spinach as compared with the other types.

Varieties: Round Leaf,
Round Leaved,
Long Standing, Round Seeded,
Long Standing,
New Parisian,
New Victoria,
Victoria.

The first four varieties have the same general characteristics; perhaps the third and fourth do not form blossom stalks quite as early as the others.

The New Parisian is an intermediate form between this group and the next; the leaves are rounded at first, but become somewhat pointed with age. It was of freer growth, and stood as well as the ordinary round-leaved variety. From our limited opportunity to observe its behavior, we should think that it might yield more bushels to the acre than the round leaf proper, and at the same time be of easier culture than the thick leaf. We had but one sample of seed of this variety.

The Victoria is a new variety of the round-leaved type. W. Atlee Burpee states in his Seed Annual for 1894 that he obtained seed of this variety from the originators in Germany during the preceding season. It is of slow growth, but a thrifty plant. Probably it is one of the latest varieties of spinach. On the Experiment Station grounds it was exceptionally free from mildew during the past season, but as a variety it presumably does not deserve any special credit on that account.

FIG. 5. Round-leaved Spinach.
Plant eighteen inches across.

GROUP III.—THICK LEAVED SPINACH.

Plants large, leaves long and spreading out upon the ground, ends and lobes of leaves more or less pointed. A highly-prized type of spinach, both for spring and fall planting, on account of its large size and rapid growth. The number of names given by seedsmen to different sorts of this type of spinach is evidence of its popularity.

Varieties: Belgium Evergreen,
Broad Leaved Flanders,
Cotillon Long Standing,
Extra Large Round Leaf,
Giant Thick Leaf,
Flanders Broad Leaf,
Flanders,
Large Round Viroflay,
Lettuce Leaved,
Long Standing,
May's Perfection,
New Long Standing,
Rawson's Round Thick Leaf,
Round Summer Broad Leaf,
Thick Leaf,
Thick Leaved,
Thick Leaved Round.

The most important differences noted in these varieties as grown upon the Experiment Station grounds were slight variations in the thickness of the leaves and in the time that the blossom stalks began to show in the crowns.

Doubtless many of the names are synonymous, and in other cases there are but slight differences in the varieties. In our opinion the variety that is known among gardeners as the Thick Leaved Spinach represents the highest development of this type. Specimens of this variety may measure two feet across when two months old, and still be in excellent condition for the table, if skillfully grown. The leaves are not as firm as those of either the Norfolk or Round Leaved types, but for a local market this variety will probably yield more bushels than either of the other kinds.

The Viroflay and Cotillon forms that we have seen have thinner and lighter colored leaves and are otherwise less desirable.

The Long Standing variety of this type appears to be an acquisition of some value. It closely resembles the Thick Leaved, but it is a smaller plant and one that does not grow quite as rapidly. It is unfortunate that this variety has been introduced under a name that previously has been associated with an entirely distinct variety of the round leaved type.

FIG. 6. Thick-leaved Spinach.

Plant two feet across.

GROUP IV.—PRICKLY SEEDED SPINACH.

Plants variable; leaves often with long and slender stalks and rather narrow blades. Seeds with horn-like projections. (See Fig. 10, page 117). This kind of spinach is not readily sown with ordinary seed drills.

Varieties: Fall,
Long Standing Prickly,
Prickly Seeded,
Prickly,
Winter.

The names under which this spinach is sold appear to be indefinite appellations that indicate only that the kind is supposed to be hardy and the seed prickly. The plants grown from this kind of seed at the Experiment Station were considerably unlike in appearance, but all agreed, in our opinion, in being inferior sorts for spring planting. The leaves were generally rather light green in color, and inclined to be thin in texture. We have seen, however, what appeared to be varieties of the Round and Norfolk Leaved types which had seeds that were more or less prickly, hence we infer that the projections upon the seeds are not necessarily confined to kinds having narrow and thin leaves, although these traits prevail among the plants grown from the prickly seed which we found upon the market.

FIG. 7. Prickly-seeded Spinach.
Plant eighteen inches across.

GROUP V.—NEW ZEALAND SPINACH.

Plants diffusely branched, spreading, often three or four feet across, leaves resembling those of the true spinach in appearance, thick, dark green, and somewhat triangular in form. Seeds inclosed in a hard, rough and depressed pod. This plant thrives in the hot summer weather, which is unfavorable for the growth of the true spinach.

Variety: New Zealand (*Tetragonia expansa*).

This plant is not generally known among gardeners, although it seems to us that it is the best of the various substitutes for spinach which we have seen. It is easily grown; the leaves are not, so far as we have observed, seriously injured by the leaf miner, and it appears to be generally relished by those who are fond of the true spinach. When the ends of the shoots are cut for use, lateral branches are formed immediately. A few plants are sufficient to furnish a family with a continual supply of fresh greens from July to October. Seeds of New Zealand spinach germinate slowly and the seedling plants are delicate, but when fairly established the plants grow vigorously throughout the season. The growth of the plants may be hastened by planting the seeds under glass in February or early in March, and then transferring them later to the open ground.

FIG. 8. New Zealand Spinach.
Plant three feet across.

GROUP VI.—MOUNTAIN SPINACH OR GARDEN ORACHE. (*Atriplex hortensis*).

Plants tall, four or more feet high when mature, with lateral branches; leaves on the plants that we have seen either light green or dark red. Seeds enclosed between two disk-like membranes. (See Fig. 10.)

Varieties : Chinese,
Chinese Red,
Holland,
Sweet Mountain.

No difference was noted between the Chinese, Holland, and Sweet Mountain plants as grown at the Experiment Station. They were all of upright growth, and had leaves that were of a peculiar light green color. The Chinese Red plants were of a dark red color throughout, and of ranker growth than the others. The leaf miner worked in the leaves of these plants quite as freely as in those of the true spinach, and on the whole we are not favorably impressed with this class of plants as culinary vegetables. When cooked they have a flavor which is unlike that of ordinary spinach, and, so far as we have learned, not generally agreeable to those accustomed to eating the true spinach.

FIG. 9. Mountain Spinach or Garden Orache.

Plant eighteen inches high.

THE USE OF WATER IN CONNECTION WITH THE CULTIVATION OF SPINACH.

The main growth of the spinach crop takes place either late in the fall or in the spring when deep moisture is usually abundant in the soil, and observations lead us to believe that under ordinary circumstances spinach can be well grown without the artificial application of water, and also that an excess of moisture in the surface soil retards the growth of the plants. Experience at the Experiment Station during the past season furnishes evidence in support of such an opinion.

Approximately one-seventh of an acre of land was planted, April 15th and 16th, to spinach for field cultivation,* the plan being to harvest this crop within eight weeks time, and set the field with celery plants about the middle of June. In preparation for the growth of these two crops the land received three and one-half cords of stable manure and 350 pounds of a high grade fertilizer. About one-half of the manure was spread broadcast upon the piece and plowed in about nine inches deep. The remainder of the manure was then spread over the field and mixed with the soil by the use of a disk harrow. The commercial fertilizer was then sown and the final leveling and pulverizing of the surface soil was done with a Meeker harrow. The piece was divided into three sections, viz.: A, B and C, running east and west, while the rows ran north and south, crossing the three sections.

Section A was sub-irrigatad, Section C was surface irrigated, and Section B which was between Section A and C was not irrigated. The sub-irrigation was effected by the use of two inch octagonal drain pipe laid eighteen inches deep, joints one-fourth inch apart, covered with tarred paper, and with a fall from the end where the water was introduced of about one-fourth inch to the foot. The ends of each line of pipe were plugged with cement and the water introduced through a hole drilled in the top of one of the pipes. Over this hole two pipes were placed in a vertical position with all joints cemented, and the upper part projecting about eight inches above the surface. The lines of pipes were ten feet apart. The water was introduced into the vertical pipes from holes in a rubber hose which was supported over them, although an iron pipe properly drilled or a wooden trough would doubtless be better for this purpose.

*Spinach is usually planted in drills from eight to twelve inches apart, although the seed is sometimes sown broadcast very early in the spring.

In Section C the water flowed over the land from the end of a hose, the hose being moved occasionally. May 4th about 2000 gallons of water were introduced into the pipes in Section A and 1500 gallons flowed on to Section C.

Although the surface soil appeared to be dry at this time the spinach in Section A was not appreciably benefited by the application of the water, still it seemed in this case to do no harm.

FIG. 10. Forms of spinach seeds as they are offered for sale.

(Natural size)

Round. (Upper left hand corner).
New Zealand. (Several seeds in a pod).
Prickly. (Upper right hand corner).
Mountain. (Lower right hand corner).

The use of the water upon the surface of Section C conspicuously hindered the growth of the spinach and during a few days that followed the application, the plants in the other two sections grew much faster. The ground was systematically soaked but twice more during the growth of the crop and this was done on May 11th and 28th. About the same amount of water was used at these times as before with about the same results. In Section A the water came to the surface over the tiles but it did not appear to spread far laterally. No difference could be detected

between the growth of the spinach that was over, and that which was between the lines of the tile.

The cuttings from the sections were as follows:

	SECTION A.	SECTION B.	SECTION C.
May,	185 lbs.	180 lbs.	102 lbs.
June,	322 "	300 "	429 "
	507 lbs.	480 lbs.	531 lbs.

Allowing 33 lbs. to a barrel, the yield from the one-seventh acre of land in eight weeks was 46 barrels, the most of which was in prime, merchantable condition when gathered. Thinning began May 13th and at this time when the wholesale price of spinach ranged from $2.00 to $2.50 per barrel the surface irrigated plot yielded only about two-thirds as much as either of the others. The plants were as numerous and equally as healthy on this as on the other plots but they did not grow as rapidly. The application of water evidently retarded rather than accelerated the development of the roots, which is what spinach growers do not usually care to do. On account of its late development the surface irrigated spinach was not thinned as much in May as that in the other sections, consequently more of the plants remained to grow and this accounts for the gain in the total yield of this plot; which however, has no special significance because it was only shown in the last few cuttings which had but little value.

THE LEAF MINER.

The leaf miner is about as certain to appear in the leaves of the true and the Mountain spinach during June, July, August and September, in Rhode Island, as spinach seed is to germinate if planted during these months, and it not infrequently spoils the crop if an attempt is made to grow it during the summer. Growers can, however, by taking advantage of what is known of the habits of this insect and securing their spinach during the cool weather of fall and spring, avoid serious interference from this pest. It fortunately happens that the period of activity of the leaf miner in this latitude does not cover the entire season in which spinach can be grown. Spinach is a hardy plant, but the leaf miner is a delicate maggot, very sensitive to cold weather. It feeds in the pulp of the leaves, between the upper and under

covering tissues, and is often destructive in the early part of September, but as frosty nights come on it disappears and causes no more trouble until the following June. This allows time to start the winter crop between the first and the middle of September, and the spring crop about the first of April, and harvest both when the leaf miner is not troublesome. No satisfactory remedy for the leaf miner that is applicable to commercial spinach culture is known. The mature insect is a fly which resembles in general appearance the common house fly, but its wings are perhaps a little longer in proportion to its body than those of that insect.

FIG. 11. Spinach Leaf* Miner in its three stages and a portion of a spinach leaf showing the work of the miner in the upper right hand corner.

(Natural size).

The fly is not generally noticed in the field. The leaf miner works in the leaves of beets, pig-weeds and other related plants. It remains in the maggot stage in the leaves about a week, then emerges and, guided by instinct, enters the ground, where its changes take place. The flies return again to the leaves and deposit their eggs, and in this way the insects are propagated throughout the season in which they can work. The prevalence of the miner in the leaves of common weeds belonging to the pig-weed family insures the presence of the mischievous flies in all localities, and few spinach fields escape their visits during the

* Entomologists tell us that several species of dipterous larvæ feed in beet and spinach leaves, but the less discriminating eye of the horticulturist may overlook the differences between them. It is supposed that the most common form is *Pegomyia vicina*.

summer, although large fields appear to be injured less than small ones by them.

MILDEW.

This is a *cool weather* torment of the cultivator of spinach and one that is not so easily evaded as the preceding. Its presence is indicated by the appearance of yellowish blotches on the older leaves which mark the progress of the mildew fungus within. In damp weather the under surfaces of these blotches are generally covered with gray spores. When severely attacked by the mildew spinach plants rapidly lose their vitality and soon present a dilapidated appearance. They may partially recover their normal vigor without any special aid from the grower, but much mildew in a field we believe may be regarded as a sign of a short crop and one of not the best quality. Mildewed spinach does not ship well. Unless extra precautions are taken after it is placed in barrels the fungus develops and rapidly breaks down the tissues of leaves which may have been firm when taken from the field. Among the various remedies recommended for the spinach mildew we have found none which seems to us to be particularly serviceable. The use of the ordinary fungicides upon the foliage appears to be impracticable because the mildew is active at about the time when the crop is ready for market and the presence of any such substance upon the leaves would be objectionable. During the past season the lime and sulphur mixture was freely applied on the surface soil along the rows and beneath the plants. It did not stop the development of the mildew even in the leaves that laid directly upon it, although the plants may have been slightly benefited by its use.

ARE THE MILDEW GERMS CARRIED INTO THE FIELD UPON THE SEED?

Our experience the past season seems to furnish evidence that such may be the case. Certainly on the Experiment Station grounds seeds of the same kinds obtained from different sources when planted at the same time and in the same rows produced plants which were affected very differently by the mildew. It generally developed quite evenly on plants from the same lot of seed, but the varieties of no particular type appeared to be especially susceptible to injuries from it. In the one-seventh acre field previously mentioned there were 18 rows, each 72 feet in length, of a Long Standing, round-leaved variety, where the

plants were uniformly badly injured by the mildew. On one side of these were three rows of the Victoria, round-leaved, and on the other 31 rows of the Thick Leaf, that were injured but slightly by the mildew, yet all the kinds were grown apparently under similar conditions. So far as could be detected the application of water upon the soil did not influence the development of the mildew upon the leaves of the spinach. Like other afflictions of its kind, the spinach mildew spreads most rapidly on affected plants in a damp atmosphere, and consequently fields attacked by it show the injuries most after a period of wet weather, but our observations revealed no evidence to show that the disease spreads at all rapidly from row to row. It appeared, on the contrary, as if the sudden outburst of the disease among the various varieties here, about the middle of May, was the culmination of a growth that had been going on about the plants unobserved for some time, and perhaps from the time that the seeds were planted. It is only in this way that we are able to explain why there was the difference in the development of the mildew that was often noted upon plants having the same general characteristics and growing near together, but which were raised from seed obtained from different sources. Since making the observations there has been no opportunity before the preparation of this matter for publication for experimenting in the use of disinfectants upon spinach seed, because the hot weather in itself appears to be unfavorable to the growth of the mildew. If, however, it should be proved that the spinach mildew is disseminated with the seed, it is probable that the seed can be disinfected before planting without injury and with comparatively little expense.

AN HISTORICAL SKETCH OF THE CULTIVATION AND USE OF SPINACH.

There is still some question about the identity of the wild form of spinach, but it is supposed that it was a native of southwestern Asia, and that its cultivation began there a thousand or more years ago. According to De Candolle[1], Ebn Baithar who was living in 1235, quoted an Arabian work which said that the cultivation of spinach was common at Nineveh and Babylon, but the plant does not appear to have been known to either the Greeks or

[1] Origin of Cultivated Plants, p. 99.

FIG. 12. Spinach plant as illustrated 264 years ago.

Copied from Parkingeons' "Theatrum botanicum: the theater of plants," published in London, 1640.

the Romans. It is supposed that its cultivation was introduced into Europe during the fifteenth century. In such Prelinnean Herbals as I have had access to (through the courtesy of Librarian Manning of the Massachusetts Horticultural Society), I find ample proof that the species has been continuously cultivated for at least four hundred years; still, our modern varieties, which are master-pieces of the gardener's skill, retain the caprices of the earlier forms. They have been brought into existence by culture, and if they are removed from the influence of this the leaves become stringy and tough and the plants spindle up immediately.

As an illustration of the accounts of spinach given by the earlier Herbalist, I may quote a part of John Parkinson's description as it appeared in his "Paradisus Terrestris," printed in London in 1629.

"Spinach, or spinage, is of three sorts—two that bear prickly seeds, the one much greater than the other; the third that beareth a smooth seed which is more daintie and nursed up in but few gardens.

"The common spinach, which is the lesser of the two prickly sorts, hath long green leaves, broad at the stalk, and rent or torn, as it were, into four corners, and sharp pointed at the ends. It quickly runneth up to stalk if it be sown in the spring-time, but if at the end of summer, it will abide all of the winter green. . . . . .

"The other greater sort that hath prickly seed is in all things like the former, but larger, both in stalk, leaf and seed. The smooth spinach hath broader and a little rounder pointed leaves than the first, especially the lower leaves; for those that grow upwards upon the stalk are more pointed. . . . . . . At the several joints of the stalk and branches stand clustering many small greenish flowers, which turn into clusters of round, whitish seed without any prickles at all upon them. If it be often cut[2] it will grow the thicker, or else spindle up very thinly with but few leaves upon the stalk. . . . . . .

"Many English, that have learned it from the Dutch people, do stew the herb in a pot or pipkin, without any other moisture than its own, and after the moisture is a little pressed from it they put butter and a little spice unto it, and make therewith a dish that many delight to eat of."

The later accounts that I have seen add little to what was

[1] Paradisi in Sole. Paradisus Terrestris, p. 496.
[2] Possibly meaning thinned in the sense that this word is now used among gardeners.

stated by Parkinson but indicate that the use of spinach steadily increased in popularity. As evidence of this John Evelyn says in his "Acetaria—A discourse of Sallets," printed also in London in 1699, that "Spinach of old was not used in sallets and the oftener kept out the better; . . . . but being boiled . . . . is a most excellent Condiment with Butter, Vinegar and Limon for almost all sorts of boiled flesh and may accompany a sick man's Diet. 'Tis . . . . profitable for the aged, and . . . . may be had at almost any season and in all places.'"

Tournefort in his Institutions,[1] printed in Paris in 1700, gives illustrations of prickly and smooth spinach seeds which show that there has been but little change in their form, at least in two hundred years. Bernard M'Mahon gives directions frequently for planting spinach in his "American Gardener's Calendar," printed in Philadelphia in 1806. He speaks as if it was commonly grown in the kitchen gardens at that time but he only mentions two varieties, viz: the prickly and the smooth. In common with European writers he advocated planting the prickly seeded late in the fall and early in the spring, and the round seeded for the summer crop. That is, the prickly seeded sort was considered hardier than the round but not as good quality. In the eleventh edition of this calendar, revised under the supervision of J. J. Smith and published in 1857, nothing is said about any new kinds of spinach, and Peter Henderson in "Gardening for Profit" which appeared ten years later, in 1867, enumerates only the two kinds given by M'Mahon sixty years before. Fearing Burr, however, in his "Field and Garden Vegetables of America," published in Boston in 1863, adds three new varieties of spinach to the list; these were the Flanders, Lettuce-leaved and Sorrel-leaved, all probably imported and little known here. This is apparently about the time that the cultivation of the Thick-leaved type of spinach began in this country, and perhaps the Flanders and Lettuce-leaved were the first varieties of it which were introduced. These were described by M'Intosh in his "Book of the Garden," published in London, before Mr. Burr's book was written and they may therefore have come to this country from England. We infer, however, that they had not long been cultivated there, but recently introduced from Holland, where it seems an unusually large growing race of smooth seeded spinach had been known for

[1] Institutiones rei harbariæ, Vol. II, p. 308.

more than three centuries. Tragus,[1] writing in 1552, calls this race *Spinacia nobilis* and De Candolle[2] states that it is evidently a garden product.

Whether the present Thick-leaved spinach is a direct descendant from this old Dutch race or not is uncertain; still there is at least circumstantial evidence that it is. The merits of this type were evidently soon recognized by growers and its introduction marks a new era in the cultivation of spinach in this country. Previous to this time the prickly-seeded variety began to be looked upon with disfavor by market gardeners, who often planted the

FIG. 13. Cutting Spinach.

View in one of J. A. Budlong & Sons' fields in Auburn. R. I., October 22d, 1896. This was the third crop taken from the land in one season. The first was early spinach and the second early cucumbers.

smooth seeded kind in the fall as well as in the spring. Peter Henderson, in a communication to the American Agriculturist [3] in 1870, says: " There has some question arisen of late whether the Round or Prickly seeded spinach is the best (for fall planting). So far as we can judge it makes but little difference which kind is used, although we use the Round almost exclusively as it is the easiest to sow." Quinn[4] writes in New Jersey, in 1871, that " Spinach is well and favorably known in every part of this

[1] Sturtevant, American Naturalist, Vol. 24, p. 726.

[2] Origin of Cultivated Plants, p. 100.

[3] Vol. 29, p. 341.

[4] Money in the Garden, p. 277.

country," and that the "Round Spinach is the most popular kind for home use or market."

The Norfolk (Savoy-leaved) spinach, introduced in the United States four years later in 1875,[1] may have been an offspring from the Flanders type, although thus far I have not been able to satisfactorily trace its origin. Dr. Oemler[2] states in 1885, that it is the variety grown about Norfolk, Va., for shipment to Northern cities, and Peter Henderson says in 1886 in the third edition of "Gardening for Profit,"[3] that "since the early editions of this book appeared, our list has been increased by two or three varieties of spinach that are not only distinct in appearance, but which, in many sections of the country, are now grown to the exclusion of the older varieties. The Savoy-leaved (Norfolk) and the Thick-leaved are both sorts that have secured this popularity."

The "Viroflay Giant" spinach was described by Vilmorin[4] in 1885 as resembling the Flanders, but of greater size. Forms of this spinach were later introduced into this country, but they have not attracted much attention. It is difficult to trace with a satisfactory degree of accuracy the origin of the different varieties of spinach now in cultivation. It is probable, however, that what we have described as the Thick-leaved type might with equal propriety (and perhaps more properly) have been called an Improved Flanders; yet, being without absolute proof of this, we have chosen the name by which it is known among spinach growers. This spinach seems to meet the requirements of both those who cultivate it and those who use it better than any other kind. In New England, at least, it is the standard sort at the present time, being equally reliable for family use or for market and for spring or fall planting.

In the history of the cultivation of New Zealand spinach we have an illustration of the tardy progress of a new vegetable when no special effort is made to advance its popularity. This plant was brought to England from New Zealand in 1771 by Sir Joseph Banks.[5] Its cultivation began immediately, and it has been grown in this country at least 40 years. Those who are familiar with it generally like it, and the press notices of it that have appeared at various times have been unusually favorable; still it is unknown

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[1] Henderson's Handbook of Plants, 2nd Edition, p. 427.
[2] Report of the Secretary of Agriculture, 1885, p. 622.
[3] P. 288.
[4] The Vegetable Garden, Eng. Edition.
[5] Origin of Cultivated Plants, p. 89.

in the markets, and it is seldom found in vegetable gardens. In a communication to the Country Gentleman[1] a writer in 1853 recommends planting New Zealand spinach for the summer crop, and in 1857 an Ohio gentleman stated in the same paper[2] that he had received seeds of the New Zealand spinach from the Patent Office at Washington. In the American Agriculturist[3] of 1863, under the heading, "New Zealand Spinach," we find the following: "Fine specimens from the garden of Wm. Shaw, of Staten Island, were exhibited at the office of the American Agriculturist. It is quite

FIG. 14. Fifty acres of spinach in one field.

View in the market gardens of J. A. Budlong & Son, October 22d, 1896.

distinct from the common spinach, and is regarded as a delicious vegetable." One year later a Mr. Mangold, from near Cincinnati, writes the same paper[4] that he considers the New Zealand spinach the most valuable of all garden vegetables. Between 1855 and 1865 the New Zealand spinach was mentioned by the agricultural press about as frequently as the true spinach, but since then the use of one has increased with remarkable rapidity, while there has been no progress worthy of mention in the use of the other.

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1 Vol. 1, p. 247.
2 Vol. 10, p. 143.
3 Vol. 22, p. 327.
4 Vol. 23, American Agriculturist, 1864, p. 111.

Why is it? These vegetables do not compete with one another. The true spinach would be out of the market before the New Zealand came in. So far as we are aware, no systematized attempt has ever been made by growers to properly introduce the use of New Zealand spinach in the cities where the people are always looking for "something new" that is fresh and green and better than they are accustomed to buying. Until this is done it is, of course, uncertain what the verdict would be, but if favorable probably a regular demand for large quantities of it would result.

There is evidence that the use of the true spinach increased rapidly after about the middle of the present century. Some of the earlier market gardeners saw in its cultivation the possibility of securing an extra crop from their fields, they tried the experiment on a large scale, introduced the product to their customers as a substitute for wild dandelions, cowslips, etc., and as a result the more spinach people used the more they wanted, and now hundreds of acres are planted annually to supply the regular demand for this vegetable. Spinach is not always a profitable crop when considered alone but it helps out those that follow and nowadays there is often need of a crop for this purpose. It is quite as important that the smaller growers should utilize the resources of their land as it is for the larger ones, for this is the way to increase the profits from the cultivation of the soil without either advancing the price of the products or reducing the price of labor.

COOKING SPINACH.

As it is necessary that spinach should be used in order that the demand for it should continue, some suggestions relating to this part of the subject seem appropriate.

In a little English book entitled "The Art of Preparing Vegetables for the Table,"[1] written some ten years ago, I find in substance the following pertinent remarks:

"Spinach may be said to divide the world into two factions, comprising those who love it and those who hate it. Perhaps many of those who hate it would come over to the happier faction if the cooks would do their duty. It is really ludicrous to hear a contented diner say "the spinach was delicious, not at all gritty."

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[1] Sutton & Sons, p. 61.

As if a cook . . . . could ever send to the table gritty spinach. But this brings us to the first stage of cooking, and that is the washing. The proper way to wash spinach is to swing it round in two or three waters, and these should not be drained from the spinach, but the floating spinach should be taken out by hand and put in another clean bowl or pan and fresh water poured upon it and the swinging repeated. If the water is cruelly cold add a little warm to it; this will not hurt the spinach and it will (prevent) . . . . the agonies that probably might explain why very often the spinach is gritty. Being washed the next stage is to cram it into a pot containing a small amount of boiling water and a liberal quantity of salt. Keep it on a strong fire and occasionally press it down with a wooden spoon and after the lapse of about ten minutes take out a little to see if it is done. The experienced cook knows in a moment without tasting it, but the young cook may be allowed to eat the sample and form an opinion. Perhaps another bubble may be good for it, and then it must be turned out into a colander and left for some minutes to drain. Now begins the finishing process, simple enough but not to be trifled with. The draining must be followed by pressing and when pressed fairly well it may be put into a dish and be chopped over with a generous allowance of butter and pepper and finally cut across into smallish portions and sent to the table, green and fragrant, and hot as fire.

There is another method which consists in putting the chopped and pressed spinach into a stew-pan with butter and pepper and placing this over the fire and stirring it until hot and comparatively dry, and then serving in a hot dish with . . . . hot buttered toast for garnishing."

It is a common practice to cook spinach in so much water that it is both unattractive in appearance and insipid in flavor when it reaches the table. To have it at its best use but little or no water and do not over-cook.

SUMMARY.

1. Spinach is a difficult crop to secure in the smaller gardens of Rhode Island only because gardeners do not take advantage of what is known concerning the cultivation of this plant.

2. Spinach plants work fast; none of the field crops yield sale-

able products from seed sooner than spring-sown spinach. These plants are also capable of working both early in the spring and late in the fall. By including spinach in the rotation one or two extra crops may often be secured from land used for trucking purposes in a single season.

3. Lean land always makes lean spinach. The modern varieties of this vegetable have become so accustomed to growing in very rich soil that the plants usually spindle up prematurely if an attempt is made to grow them even on soil of moderate fertility.

4. By beginning to cut spinach early, and thinning out the plants so that they never crowd in the row, the season of cutting from a single sowing of seed can be prolonged for several weeks.

5. There are four types among the varieties of the true spinach now cultivated in this country which have characters more or less distinct. They are the Norfolk, the Round Leaved, the Thick Leaved, and the Prickly Seeded.

6. Norfolk spinach is not popular among growers in Rhode Island, on account of its habit of "going to seed" earlier than other kinds.

7. Round Leaved spinach is of firm texture and ships well, but it is not extensively grown.

8. Thick Leaved spinach is characterized by its rapid growth and large size. It is enormously productive and particularly valuable for a near market.

9. Prickly Seeded spinach, as sold by seedsmen, is planted but little by spinach growers in Rhode Island.

10. The New Zealand spinach is not closely related to the true spinach, botanically, neither is it a plant of similar habits, but when cooked it makes an excellent substitute for that vegetable, and it can be grown to perfection during the hot summer months, when the growth of the true spinach is impracticable.

11. By starting the seed under glass in February New Zealand spinach plants may be had that are large enough to trim when the Leaf Miner begins to work in the leaves of the true spinach.

12. New Zealand spinach is but little known either in the markets or gardens in Rhode Island.

13. Mountain spinach, or Garden Orache, has a peculiar flavor that was not relished by those who received samples of this plant from the Experiment Station grounds. Its leaves are injured as badly as those of the true spinach by the Leaf Miner during warm weather.

14. Although there was less rainfall last spring than usual, sub-irrigation did not apparently benefit, and surface irrigation noticeably retarded, the growth of spinach upon the Experiment Station grounds.

15. The Leaf Miner seriously interferes with the growth of spinach during warm weather, but a crop can be secured in the spring and another in the fall without trouble from this insect. The presence of pig-weeds, beets, etc., probably encourages the propagation of the Leaf Miner.

16. There are indications that the germs of spinach mildew may be carried into the field upon the seeds. If this should prove to be the case spinach seed can probably be disinfected before planting, to the advantage of the crop.

17. Spinach has probably been cultivated for a thousand years, but its cultivation does not appear to have been undertaken in Europe until the fifteenth or sixteenth century.

18. The most progress in the cultivation of this vegetable seems to have been made within the last fifty years. During this time the use of spinach has increased rapidly in the United States.

19. The introduction of the cultivation of spinach marks a certain progress in the art of gardening, because it enables gardeners to use their land at a season when it would otherwise be idle.

Bulletin 42. December, 1896.

KINGSTON, RHODE ISLAND.

FERTILIZERS.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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*The duties of the former Poultry Manager have been assigned to the Agriculturist.

†Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 42.

FERTILIZERS.

H. J. WHEELER, B. L. HARTWELL AND C. L. SARGENT.

This bulletin, together with bulletins 39 and 40, contains the analyses of all of the commercial fertilizers collected in connection with the State inspection for the year 1896.

Attention is called to the fact that in Bulletin 39 the analysis on page 67, published as that of the Pacific Guano Co.'s Special Potato Manure, was the analysis of the Lowell Fertilizer Co.'s Potato Phosphate; while the analysis published as that of the Lowell Fertilizer Co.'s Potato Phosphate was that of the Pacific Guano Co.'s Special Potato Manure. It will be seen that the Lowell Fertilizer Co.'s Potato Phosphate should have been published as containing 3.47 per cent. of nitrogen, which brings it above the guaranty. The potash found, however, was 3.82 per cent. instead of 5.19 per cent. as previously published. Owing to this interchange, a second sample of the Lowell Potato Phosphate was drawn from goods in the hands of the same agent and was found to be above the guaranty in potash, but it was subsequently learned that this lot was from another shipment. Attention should be called to the fact that the Pacific Guano Co.'s Special Potato Manure which as published was below the guaranty in potash is really .19 per cent. above the guaranty. It was likewise above the guaranty in every other particular.

Out of seventy-seven cases where manufacturers of fertilizers have stated that the amount of potash in their goods was equal to a given per cent. of sulfate of potash, it appears that sulfate of potash was actually used in any considerable quantity, in but fourteen instances. Wherever a star is published in the chlorin column behind a given brand of goods, this is sufficient evidence that high grade sulfate of potash was not used in its manufacture but on the contrary, muriate of potash or some form of low grade sulfate containing a high percentage of chlorin.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
696	American Fert. Co.'s Ward's Inodorous Plant Food.	American Fert. Co., 153 Milk st., Boston..	M. Butler & Son, Newport.
635	Baker's A. A. Ammoniated Superphosphate........	H. J. Baker & Bro., 93–97 William st., N.Y.	Herman Peckham, Newport.
664	Bowker's Bristol Fish and Potash	Bowker Fert. Co., 43 Chatham st., Boston.	R. Barnett, Woonsocket.
598	" Gloucester Fish and Potash.............	" " " " "	H. W. Partelow, Wakefield.
572	" Stockbridge Manure for Onions	" " " " "	Wardwell Lumber Co., Bristol.
649	" " " " Peas and Beans..	" " " " "	Hoxie Bros. Co., Phenix.
668	" " " " Strawberries.....	" " " " "	Halliday Bros., E. Providence.
672	Bradley's Columbia Fish and Potash.....	Bradley Fert. Co., State st., Boston.......	" " "
578	" Fish and Potash "B"...........	" " " "	Seymour Bros., Warren.
608	" Niagara Phosphate.....................	" " " "	F. F. Haswell & Son, Westerly.
642	Brightman's Fish and Potash..	W. J. Brightman & Co., Tiverton, R. I...	John E. Arnold, Wyoming.
580	Church's Fish and Potash "D"......	Daniel T. Church, Tiverton, R. I........	Wardwell Lumber Co., Bristol..
600	Clark's Cove Bay State Fertilizer.................	Clark's Cove Fert. Co., State st., Boston...	H. W. Partelow, Wakefield.
590	" " Fish and Potash....................	" " " " " "	" " "

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorin.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed	Found.	Guaranteed.		
696	Am. Fert. Co.'s Ward's Inodorous Plant Food	3.62	....	..	**3.62**	*4.00*	.35	2.70	11.69	**14.74**	*14.0*	**3.05**	....	**.47**	[3]...	.24	*$17.98*
635	Baker's AA Ammoniated Superphosphate....	.50	1.28	1.00	**2.78**	*2.47*	7.85	3.14	.87	**11.86**	*11.0*	**10.99**	*10.0*	**2.90**	*2.0*	*	*22.73*
664	Bowker's Bristol Fish and Potash..........	.59	....	1.41	**2.00**	*1.60*	3.70	5 44	3.63	**12.77**	*8.0*	**9.14**	*5.0*	**2.26**	*2.0*	*	*18.53*
598	Bowker's Gloucester Fish and Potash.......	.31	...	1.30	**1.61**	*.75*	4.59	4.67	3.71	**12.97**	*9.0*	**9.26**	*6.0*	**1.98**	*1.0*	*	*17.46*
572	Bowker's Stockbridge Manure for Onions...	2.56	....	2.56	**5.12**	*4.50*	3.51	2.45	4.93	**10.89**	*8.0*	**5.96**	*7.0*	**6.38**	*5.0*	*	*28.10*
649	Bowker's Stockbridge Manure for Peas & Beans	1.10	....	1.66	**2.76**	*2.00*	3.62	2.94	6 19	**12.75**	....	**6.56**	*6.0*	**9.32**	*6.0*	*	*25.41*
668	Bowker's Stockbridge Manure for Strawberries	.76	...	1.78	**2.54**	*2.50*	4.63	3.99	4.95	**13.57**	*7.0*	**8.62**	*6.0*	**4.08**	*4.0*	.70	*22.08*
672	Bradley's Columbia Fish and Potash	.35	....	1.66	**2.01**	*1.65*	4.48	4.47	3.20	**12.15**	*6.0*	**8.95**	*5.0*	**3.45**	*2.0*	*	*19.39*
578	Bradley's Fish and Potash, "B"...........	.13	.20	2.04	**2.37**	*2.07*	1.64	4.51	2.70	**8.85**	*7.5*	**6.15**	*6.0*	**2.34**	*2.0*	*	*16.16*
608	Bradley's Niagara Phosphate........... ..	.08	....	1.20	**1.28**	*.82*	3.25	4.76	2.17	**10.18**	*8.0*	**8.01**	*7.0*	**1.69**	*1.09*	*	*14.31*
642	Brightman's Fish and Potash..............	.10	.22	2.33	**2.65**	*2.07*	2.01	3.99	2.55	**8.55**	*7.5*	**6.00**	*6.0*	**2.21**	*2.0*	*	*16.66*
580	Church's Fish and Potash, "D"......	.08	.21	1.97	**2.26**	*2.07*	1.97	4.33	2.37	**8.67**	*7.5*	**6.30**	*6.0*	**2.48**	*2.0*	*	*16.05*
600	Clark's Cove Bay State Fertilizer...........	.49	....	2.36	**2.85**	*2 47*	4.91	4.93	2.88	**12.72**	*10.0*	**9.84**	*9.0*	**2.14**	*2.0*	*	*21.34*
590	Clark's Cove Fish and Potash...............	.09	.22	1.93	**2.24**	*2.06*	1.92	4.54	2.96	**9.42**	*7.0*	**6.46**	*6.0*	**2.34**	*2.0*	*	*16.24*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulfate of potash was probably used.
[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.
[2] The schedule of prices used in estimating these values is to be found in Bulletin 39, page 68.
[3] There was no guaranty for potash, but 16 per cent. of "Alkali" was guaranteed.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
626	Clark's Cove King Philip Alkaline Guano.........	Clark's Cove Fert. Co., State st., Boston...	Chas. H. Ward, Middletown.
698	Cleveland Dryer Co.'s High Grade Complete Manure.	Cleveland Dryer Co., Cleveland, O........	Lewis C. Grinnell, Kingston.
614	Coe's American Lawn Dressing..................	E. Frank Coe, 16 Burling Slip, New York.	C. W. Willard, Westerly.
616	Coe's Ground Bone and Potash..................	" " " " "	" " "
657	Crocker's General Crop Phosphate..........	Crocker Fert. and Chem. Co., Buffalo, N. Y.	R. F. Brooks, Harrisville.
691	Crocker's Universal Grain Grower.	" " " " "	P. B. Wilbur, Central Falls.
673	Darling's Garden and Lawn Fertilizer.	L. B. Darling Fert. Co., Pawtucket, R. I.	L. B. Darling Fert. Co., Pawt.
684	Lowell Fert. Co.'s Vegetable and Vine Phosphate...........	Lowell Fertilizer Co., Lowell, Mass.......	Martin Bros., Barrington.
561	Mapes' Cereal Brand......	Mapes Formula & Peruv. Guano Co., N. Y.	Seymour Bros., Warren.
568	Mapes' Complete Manure for Top Dressing........	" " " " "	" " "
587	Mitchell's Standard Special for Market Gardeners..	Mitchell Fertilizer Co., Tremley, N. J.....	A. A. Wilbur, Allenton.
563	National Fert. Co.'s Chittenden's Fish and Potash..	National Fert. Co., Bridgeport, Conn.....	N. N. Cole, Bristol.
634	National Fert. Co.'s Chittenden's Ammoniated Bone Phosphate....	" " " "	Geo. Coggeshall, Middletown.

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorin.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
626	Clark's Cove King Philip Alkaline Guano....	.50	....	1.33	**1.83**	*1.03*	3.67	4.53	1.92	**10.12**	*9 00*	**8.20**	*8.0*	**3.00**	*2.0*	*	*$17.11*
698	Cleveland Dryer Co.'s H. G. Complete Manure	1.42	....	2.02	**3.44**	*3.30*	3.24	5.66	2.11	**11.01**	*9.00*	**8.90**	*8.0*	**6.82**	*7.0*	*	*25.69*
614	Coe's American Lawn Dressing.............	.14	1 99	2.02	**4.15**	*4.00*	trace	6.38	8.14	**14.52**	... .	**6.38**	*11.0*	**6.09**	*5 5*	.50	*27.67*
616	Coe's Ground Bone and Potash......	....	....	1.93	**1.93**	*2.00*	.17	3.68	10.95	**14.80**	*12.82*	**3.85**	...	**2.80**	*2.5*	*	*16.17*
657	Crocker's General Crop Phosphate.........	...	....	.91	**.91**	*.82*	4.95	2 06	3.51	**10.52**	*8.00*	**7.01**	*7.0*	**1.19**	*1.08*	*	*12.53*
691	Crocker's Universal Grain Grower	....	....	1.05	**1.05**	*.82*	4.13	2.08	3 63	**9.84**	*8.00*	**6.21**	*7.0*	**4.13**	*2.7*	*	*14.73*
673	Darling's Garden and Lawn Fertilizer.......	.97	....	2.75	**3.72**	*4.00*	2.99	4.16	6.14	**13.29**	*10.00*	**7.15**	....	**5.69**	*5.0*	*	*25.35*
684	Lowell Fert. Co.'s Vegetable and Vine Phos..	.45	....	2.72	**3.17**	*2.47*	4.73	6.25	1.66	**12.64**	*8.00*	**10.98**	*7.0*	**6.44**	*6.0*	*	*26.75*
561	Mapes' Cereal Brand	.13	...	1.84	**1.97**	*1.65*	4.63	2.20	1.87	**8.70**	*8.00*	**6.83**	*6.0*	**3.44**	*3.0*	*	*16.64*
568	Mapes' Complete Manure for Top Dressing..	2.32	....	.39	**2.71**	*2.47*	.77	2.68	1.46	**4.91**	*3.50*	**3.45**	....	**3.17**	*2.5*	*	*14.31*
587	Mitchell's Stan. Special for Market Gardeners	.49	....	1.86	**2.35**	*2.00*	7.85	2.28	1.59	**11.72**	*9.00*	**10.13**	*8.0*	**2.53**	*2.0*	.50	*20.55*
563	Nat. Fert. Co.'s Chittenden's Fish and Potash	.12	....	2.25	**2.37**	*2.47*	1.84	3.50	3.46	**8.80**	*8.00*	**5.34**	...	**4.08**	*3.0*	*	*17.19*
634	Nat. Fert. Co.'s Chittenden's Am. Bone Phos.	....	....	1.93	**1.93**	*1.65*	.30	9.79	1.18	**11.27**	*9.00*	**10.09**	*7.0*	**3.00**	*2.0*	*	*18.69*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulfate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in Bulletin 39, page 68.

Sample No.	Name of Brand.	Manufacturer.	Dealer.
636	Pacific Guano Co.'s Soluble Pacific Guano.......	Pacific Guano Co., Box 1368, Boston, Mass	A. P. Smith, Newport.
691	Parmenter & Polsey's Star Brand Superphosphate.	Parmenter & Polsey, Peabody, Mass......	V. V. Hart, Davisville.
688	Peters' Sheep Fertilizer........................	John J. Peters, Long Island City, N. Y...	W. A. Potter & Co., Providence.
617	Quinnipiac Climax Phosphate..................	The Quinnipiac Co., 92 State st., Boston..	E. A. Kenyon, Carolina Mills.
618	" Phosphate.......	" " " "	" " " "
670	Read's Fish, Bone and Potash	Read Fert. Co., New York.	D. C. Curtis, Apponaug.
663	" Standard Superphosphate................	" " "	" " "
609	Russia Cement Co.'s Essex X. X. X. Fish and Potash.................	Russia Cement Co., Gloucester, Mass......	F. P. Babcock, Westerly.
611	Russia Cement Co.'s Odorless Lawn Dressing....	" " " "	" " "
623	Standard Fert. Co.'s Standard Guano........ ...	Standard Fertilizer Co., State st., Boston..	Geo. A. Weaver Co., Newport.
693	Wilcox's Fruit, Vine and Vegetable Manure.....	Wilcox Fertilizer Works, Mystic, Conn...	A. H. Tefft, Davisville.
654	" Grass Fertilizer.................... ...	" " " " " ...	Hopkins & Hopkins, Oakland.
576	" High Grade Fish and Potash..........	" " " " " ...	Seymour Bros., Warren.

Sample No.	Name of Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorin.	Valuation of the nitrogen, phosphoric acid and potash in one ton.[2]
		Nitrogen in nitrates.	Nitrogen in ammonia salts.[1]	Nitrogen in organic matter.	Total nitrogen found.	Nitrogen guaranteed.	Soluble.	Reverted.	Insoluble.	Total found.	Total guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
636	Pacific Guano Co.'s Soluble Pacific Guano...	.43	....	1.73	**2.16**	*2.25*	5.26	3.25	2.71	**11.22**	*10 5*	**8.51**	*8.5*	**2.20**	*2.0*	*	*$18.10*
690	Parmenter & Polsey's Star Brand Superphos.	....	....	1.90	**1.90**	*1.65*	2.92	4.55	1.60	**9.07**	*8.00*	**7.47**	*7.0*	**2.66**	*2.5*	*	*16.11*
688	Peters' Sheep Fertilizer....................	....	....	1.42	**1.42**	*2.36*	....	....	..	**.68**	*[4]4.62*	.....	....	**2.75**	*2.16*	....	*[3]7.34*
617	Quinnipiac Climax Phosphate	.10	....	1.19	**1.29**	*1.03*	4.29	3.77	2.11	**10.17**	*9.00*	**8.06**	*8.0*	**2.18**	*2.0*	*	*14.89*
618	Quinnipiac Phosphate.....................	.46	...	2.22	**2.68**	*2.47*	4.96	4.93	2.14	**12.03**	*12.00*	**9.89**	*9.0*	**2.09**	*2.0*	*	*20.59*
670	Read's Fish, Bone and Potash...............	.17	....	2.51	**2.68**	*2.47*	3.11	1.33	1.42	**5.86**	*5.00*	**4.44**	*4.0*	**4.18**	*4.0*	*	*16.57*
663	Read's Standard Superphosphate.......	.11	....	1.14	**1.25**	*.82*	5.86	2.50	.99	**9.35**	*9.00*	**8.36**	*8.0*	**4.64**	*4.0*	*	*17.02*
609	Russia Cement Co.'s Essex XXX Fish & Potash	....	....	2.39	**2.39**	*2.06*	2.76	5.00	6.82	**14.58**	*12.00*	**7.76**	*10.0*	**2.37**	*2.25*	*	*19.59*
611	Russia Cement Co.'s Odorless Lawn Dressing.	....	4.04	....	**4.04**	*3.71*	.50	5.00	2.79	**8.29**	*7.00*	**5.50**	*5.5*	**8.35**	*7.0*	*	*26.31*
623	Standard Fert. Co.'s Standard Guano........	.09	...	1.08	**1.17**	*1.03*	3.66	5.04	2.27	**10.97**	*10.00*	**8.70**	*8.0*	**2.12**	*2.0*	*	*15.15*
693	Wilcox's Fruit, Vine and Vegetable Manure.	1.14	.27	1.72	**3.13**	*3.00*	2.51	4.14	2.66	**9.31**	*7.00*	**6.65**	*6.0*	**9.88**	*10.0*	6.	*25 75*
654	Wilcox's Grass Fertilizer..	1.93	....	3.01	**4.97**	*4.00*	3.47	2.93	3.90	**10.30**	*7.00*	**6.40**	*6.0*	**6.94**	*5.0*	*	*28.28*
576	Wilcox's High Grade Fish and Potash.......	.18	.39	3.09	**3.66**	*3.25*	2.94	2.81	1.02	**6.77**	*6.00*	**5.75**	*5.0*	**4.94**	*4.0*	*	*21.21*

* The amount found was more than equivalent to the potash, showing that muriate or low grade sulfate of potash was probably used.

[1] When less than .2 per cent. has been found it has been included with the organic nitrogen.

[2] The schedule of prices used in estimating these values is to be found in Bulletin 39, page 68.

[3] Phosphoric acid valued at 4½ cents and potash at 5 cents per pound.

[4] The marking on the bags was very indistinct, and the guaranty for phosphoric acid was subsequently claimed by the importer to have been 1.62 per cent.

Sample No.	NAME OF BRAND.	WHOLESALE DEALER.	PLACE OF COLLECTION.	PURCHASER.
547	Unleached Hard-Wood Ashes.........	T. H. Frauley, Brookline, Mass.........	Slocumville.	A. P. Sweet, Slocumville.
548	" " "	" " " "	"	Robert Rodman, Slocumville.
581	" " "	" " " "	E. Greenwich	....
620	" " "	" " " "	Wickford Jc.	....
621	" " "	" " " "	" "	....
675	" " "	" " " "	Portsmouth.	....
687	" " "	" " " "	"	....
680	Canada Hard-Wood Ashes............	Monroe, Lalor & Co., Oswego, N. Y......	"	Henry Hedly, Portsmouth.
700	Wood Ashes............	" " " " "	Niantic.....	Calvin Davis, Niantic.
701	" "	" " " " "	Jackson.....	I. W. Brayton, Fiskeville.

Sample No.	NAME OF BRAND.	Date of Collection.	Phosphoric acid found.	Phosphoric acid guaranteed.	Potash found.	Potash guaranteed.	Valuation of phosphoric acid and potash contained in one ton.*
547	Unleached Hard-Wood Ashes.	Mar. 18, 1896.	2.07	.50	6.21	5.00	$8.07
548	Unleached Hard-Wood Ashes.	Mar. 18, 1896.	2.33	.50	7.77	5.00	9.87
581	Unleached Hard-Wood Ashes.	April 16, 1896.	2.51	......	7.05	......	9.31
620	Unleached Hard-Wood Ashes.	April 21, 1896.	2.06	.50	6.77	5.00	8.62
621	Unleached Hard-Wood Ashes.	April 21, 1896.	1.59	.50	5.43	5.00	6.86
675	Unleached Hard-Wood Ashes.	May 5, 1896.	2.17	1.50	7.07	5.00	9.02
687	Unleached Hard-Wood Ashes.	May 5, 1896.	2.70	1.50	6.66	5.00	9.09
680	Canada Hard-Wood Ashes.	May 5, 1896.	1.38	1.00	8.32	4.50	9.56
700	Wood Ashes.	Aug. 31, 1896.	1.48	......	5.65	......	6.98
701	Wood Ashes.	Oct. 15, 1896.	1.19	......	5.25	......	6.32

*The price allowed for phosphoric acid and potash in wood ashes is 4½ cents for the former and 5 cents per pound for the latter, or the same as for potash in the form of "high grade sulfate." The ashes contained considerable lime and some magnesia, the amount of which was not determined and for which no *commercial* value has been allowed. The value of each to the farmer, or *agricultural* value, is dependent upon the amount of the same in the soil and the wants of the crop to be raised.

Table showing the number of complete fertilizers analyzed during the present season, the manufacturers of the same, and the relation of the guaranties to the amounts of nitrogen, phosphoric acid and potash found.

MANUFACTURER.	Nitrogen.			Total Phosphoric Acid			Available Phos. Acid.			Potash.			Summary.				
	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of guaranties.	No. equal to or above guaranty.	No. .3 per cent. or more below guaranty.	No. of brands analyzed.	Total No. of guaranties.	Total No. equal to or above guaranty.	Total No. less than .3 per cent. below guaranty.	Total No. more than .3 per ct. below guaranty.
American Fertilizer Co., 153 Milk street, Boston, Mass	2	1	1	2	1	1	...	...	...	...	...	...	2	4	2	0	2
H. J. Baker & Bro., 93–97 William street, New York	3	3	0	2	2	0	3	3	0	3	3	0	3	11	11	0	0
Bowker Fertilizer Co., 43 Chatham street, Boston, Mass	16	16	0	15	15	0	16	13	3	16	13	1	16	63	57	2	4
Bradley Fertilizer Co., State street, Boston, Mass	11	10	0	11	11	0	11	11	0	11	10	1	11	44	42	1	1
W. J. Brightman & Co., Tiverton, R. I	3	3	0	3	3	0	3	3	0	3	3	0	3	12	12	0	0
Daniel T. Church, Tiverton, R. I	3	2	0	3	3	0	3	3	0	3	2	1	3	12	10	1	1
Clark's Cove Fertilizer Co., State street, Boston, Mass	5	5	0	5	5	0	5	3	0	5	5	0	5	20	18	2	0
Cleveland Dryer Co., Cleveland, Ohio	3	3	0	3	3	0	3	3	0	3	1	0	3	12	10	2	0
E. Frank Coe Co., 16 Burling Slip, New York	4	3	0	3	3	0	3	2	1	4	4	0	4	14	12	1	1
Crocker Fertilizer and Chemical Co., Buffalo, N. Y	5	5	0	5	5	0	5	3	2	5	5	0	5	20	18	0	2
Cumberland Bone-Phosphate Co., Portland, Me	2	2	0	2	2	0	2	2	0	2	1	0	2	8	7	1	0
L. B. Darling Fertilizer Co., Pawtucket, R. I	4	3	0	4	4	0	3	3	0	4	4	0	4	15	14	1	0
Great Eastern Fertilizer Co., Rutland, Vt	1	1	0	1	1	0	1	1	0	1	1	0	1	4	4	0	0
Lowell Fertilizer Co., Lowell, Mass	3	3	0	3	3	0	3	3	0	3	1	1	3	12	10	1	1
Mapes Formula and Peruvian Guano Co., New York	5	5	0	5	5	0	4	3	0	5	5	0	5	19	18	1	0
Mitchell Fertilizer Co., Tremley, N. J	3	3	0	3	3	0	3	3	0	3	2	0	3	12	11	1	0
National Fertilizer Co., Bridgeport, Conn	4	3	0	4	4	0	3	3	0	4	4	0	4	15	14	1	0
Pacific Guano Co., Box 1368, Boston, Mass	3	2	0	3	3	0	3	3	0	3	2	1	3	12	10	1	1
Parmenter & Polsey, Peabody, Mass	3	2	0	3	3	0	3	3	0	3	3	0	3	12	11	1	0
John J. Peters, Long Island City, N. Y	1	0	1	1	0	1	...	...	...	1	1	0	1	3	1	0	2
The Quinnipiac Co., 92 State street, Boston, Mass	5	5	0	5	5	0	5	5	0	5	4	1	5	20	19	0	1
Read Fertilizer Co., New York, N. Y	4	4	0	4	4	0	4	4	0	4	4	0	4	16	16	0	0
Russia Cement Co., Gloucester, Mass	5	4	0	5	5	0	5	2	3	5	4	1	5	20	15	1	4
Lucien Sanderson, New Haven, Conn	1	1	0	1	0	0	1	1	0	1	1	0	1	4	3	1	0
M. L. Shoemaker & Co., Philadelphia, Pa	1	1	0	1	1	0	1	1	0	1	1	0	1	4	4	0	0
Standard Fertilizer Co., State street, Boston, Mass	3	3	0	3	3	0	3	3	0	3	3	0	3	12	12	0	0
Wilcox Fertilizer Works, Mystic, Conn	6	6	0	6	6	0	6	6	0	6	5	0	6	24	23	1	0
Williams and Clark Fertilizer Co., 92 State street, Boston, Mass.	4	3	0	4	4	0	4	4	0	4	4	0	4	16	15	1	0

Below is given a tabular statement showing the improvement in the quality of the fertilizers offered for sale in this State from 1891 to 1896 inclusive.

	1891	1892	1893	1894	1895	1896
Equal to or above the guaranty..........	71.1	89.7	75.7	80.9	89.0	90.7
Less than .3 per cent. below the guaranty.	10.6	9.0	13.8	8.0	5.0	4.8
More than .3 per cent. below the guaranty	18 3	10 3	10.5	11.1	6.0	4.5

This season, as will be observed, the goods were found equal to or above the guaranty in 90.7 per cent. of the cases. The highest record heretofore attained was that of 1895, when it was 89 per cent., while in 1891 it will be seen that this percentage was only 71. The percentage less than .3 per cent. below the guaranty is lower than ever before, while the percentage *more* than .3 per cent. below the guaranty, which amounted in 1891 to 18 per cent., was reduced in 1895 to 6 per cent., and the past season to 4.5 per cent. Here is the most conclusive evidence that those manufacturers who do business in this State are making their goods more nearly equal to the guaranties attached to the bags in which they are sold than has been the case in any year heretofore. It is interesting to note likewise that those parties who have gone out of the fertilizer business in this State have been those as a rule whose goods were found to be very deficient, in fact, one of these parties stated in a letter that owing to the "unnecessary remarks" in our bulletin he had been unable to secure any agents in the State the following year. The official organ of the fertilizer manufacturers, the *American Fertilizer*, berates the Stations occasionally and does not seem to take kindly to the idea of state control of their products. This organ would make it appear that the inherent honesty of all men engaged in the fertilizer business was sufficient in and of itself to keep the goods up to the standard guaranteed, and that the inspection was a wholly needless interference with legitimate business interests. The fact, however, that a most wonderful change in the quality of the goods sold in this State has resulted since the begining of a vigorous inspection, affords very conclusive evidence that the inspection is not without its moral effect upon the manufacturers of fertilizers, for human nature has probably not changed so materially during the last six years. At all events, the farmers of the State have every reason to feel that they get nearer what they pay for in their fertilizers at the present time than ever before.

It is of interest to note the rapid increase in the number of brands of fertilizing material for sale in the Rhode Island market. Some six years ago fifty brands was the maximum number collected and analyzed in a single season. Two years ago the number slightly exceeded one hundred, last year it amounted to one hundred and twenty-five and this year to one hundred and fifty-one.

One striking feature in connection with the fertilizer trade is the rapid mutiplication of brands. The number of brands offered for sale in this State by certain fertilizer companies may well be termed as excessive and far beyond the agricultural requirements, and in a neighboring State we are credibly informed that the number of brands manufactured and put on the market by one company the past season, exceeded one hundred. It must be obvious that the multiplication of brands increases the expense to the manufacturer and also that connected with the proper inspection of the goods, both of which the farmer must eventually pay. It is claimed on the part of manufacturers that this is done to meet a demand on the part of the farmer, but we have reason to believe that it is more for the purpose of meeting competition with other firms than for any other reason. One of the most sensible suggestions in connection with this matter which has come to our notice was that made by Assistant Secretary of Agriculture, Chas. W. Dabney, Jr., who proposes that a few brands only should be manufactured, somewhat upon the following plan: There might be a fertilizer which was moderately rich in potash and phosphoric acid and especially high in nitrogen which might be classed as a special nitrogenous fertilizer. There might be another brand moderately rich in potash and nitrogen and especially rich in phosphoric acid, which would be classed as a special phosphoric acid fertilizer, and another fairly rich in phosphoric acid and nitrogen, and especially rich in potash, which would be classed as a special potash fertilizer. By the addition of a like number of combinations, brands could be made particularly rich in two ingredients and poorer in a third, which could be classed as special potash-nitrogen, potash-phosphoric acid, and nitrogen-phosphoric acid fertilizers. Thus these few brands could be made to answer practically all of the purposes of the farm.

It would be a most desirable feature likewise if the manufacturers of fertilizers would employ but one percentage in stating the amount of each ingredient; that is, if they would make a state-

ment that the goods contained 2 per cent. of nitrogen rather than that they contained from 2 to 4 per cent., for anything which simplifies the guaranty makes it less confusing to those not fully familiar with such matters. The Stations in publishing guaranties pay usually no attention whatever to the higher percentage, for it really means nothing. The lower one represents the actual guaranty and is the only one that the farmers should consider in buying the goods.

It would be a most desirable feature also if all manufacturers would abandon the use of the term "ammonia" for expressing the amount of nitrogen present, and where the statement is made that the goods contain nitrogen equal to a given per cent. of ammonia, it is probably for the purpose of making the figures a little larger with the hope thus of catching the farmer's eye. However, the farmer who is well informed is not thus to be deceived, for he knows that 17 pounds of ammonia are equal to but 14 pounds of nitrogen.

So far as possible the attempt has been made in this State, even though at much additional expense, to determine as much as possible in regard to the quality of the individual brands analyzed. Analyses as published by this Station show definitely the amount of nitrogen present in the form of nitrates, such as nitrate of soda; and in the form of ammonia salts such as sulfate of ammonia, and likewise the amounts of soluble, reverted and insoluble phosphoric acid, together with the probable form of the potash used. No method is known for determining *unquestionably* the source of the organic nitrogen in fertilizers, and it is well known that if this is derived from blood, bone, fish and meat, it is far more valuable for the farmer than when present as leather and in materials of similar character. The amount of phosphoric acid reported as reverted, which is also covered by the available (since the sum of the soluble and reverted makes up the available) varies unquestionably in agricultural value, according to the material from which it is derived. That which is present in the fertilizer in combination with iron and alumina is undoubtedly of very inferior value as compared with that present in the form of dicalcic phosphate. Therefore so far as concerns the character of the materials making up the organic nitrogen and the reverted and available phosphoric acid, absolute information is not furnished by the chemical analyses as given, and this is one of the strong arguments in favor of the home mixing of fertilizers, for

where this is adopted the farmer is enabled to buy the individual ingredients with less danger of imposition and mix them himself at an expense ranging from fifty cents to one dollar per ton.

Owing to the inability of a chemical analysis to show with absolute certainty the source of all the fertilizing ingredients which enter into mixed fertilizers, it must be obvious that the goods of parties who use inferior forms of nitrogen and phosphoric acid may be valued upon the same basis as those of other parties who use the best materials. On this account a certain measure of injustice is connected with the valuation of fertilizers, and this is one of the strongest reasons advanced by the manufacturers for the omission of valuations on the part of Experiment Stations. It would seem, however, that there would for the same reasons be objections to the publication of analyses at all, yet the value of these analyses no one will deny. Every attempt is made to show the relative merit of the goods, and *it is far better to continue doing the best that can be done* than to abandon a thing because one cannot accomplish at once *everything* which is desired, and both farmers and honest manufacturers will at once admit that though chemical analyses cannot tell everything, they are nevertheless of great assistance in securing the sale of better grades of goods.

In previous publications of this Station it has been stated that if those who purchase and use fertilizers were fully informed in regard to the chemistry of the same, it would doubtless be better to omit altogether the commercial valuation. The time, however, when such valuations may be omitted in this State depends upon the acquisition of such knowledge on the part of the mass of purchasers of commercial fertilizers, and until the law which makes the publication of commercial valuations compulsory on the part of the Station is changed, it must necessarily be continued. There seems to be no question but that *the chief thing which the farmer should take into consideration is the analysis of the goods*, the commercial valuation being a secondary consideration, for while this valuation may be and usually does assist and serve in some measure as a guide to those who have no knowledge of the chemical composition of fertilizers, it must be obvious that where purchases are made upon such a system only, a farmer whose land is extremely deficient in phosphoric acid might buy a fertilizer extremely rich in nitrogen and potash on account of its high valuation, and nevertheless find it to be almost wholly useless

upon his land. Whatever can be done, therefore, to bring the mass of farmers in this State to study more closely into the chemistry of the fertilizers which they use, cannot but prove of the utmost benefit to them, and it cannot be expected that farming in this or any other State where fertilizers are a necessity can be brought to the highest possible standard until those who use fertilizing materials become fully acquainted with the chemical questions involved in their use. In coming in contact with the farmers of the State it has been observed by us as a most lamentable fact that many of those who buy fertilizers have little or no idea of their composition. This condition is so prevalent that it would seem that the adoption of some such plan as that employed in Germany for disseminating facts in relation to agricultural topics would be desirable. Under this system some competent person could be employed whose business it would be to give sufficient lectures to bring out the chief points involved, the lectures to be given in every portion of the State and at points and times so arranged that all farmers could avail themselves of the opportunity to profit by them. If a system of evening schools like this could be put in operation in this State much more could be accomplished in special lines, and at less cost than by the more or less sporadic plan of farmers' institutes in vogue in most of the States.

Owing to the present low prices and prevailing depreciation in agricultural property it is manifest that there has been no time in the history of this country when such work was more needed than at present. If we as a nation are to compete in the markets of the world for a part of the trade in agricultural products, the farmers of the country must become as thoroughly informed in relation to the points connected with their business as are our progressive manufacturers in their lines, and in this way only can the United States maintain her position in competition with the other agricultural nations of the world.

A POINT FOR THE CONSIDERATION OF PERSONS SELLING FERTILIZERS IN RHODE ISLAND.

It should be perfectly understood by all parties who sell, offer or expose for sale in Rhode Island any fertilizing material at ten dollars or more per ton, that they become liable to a fee of six dollars for each fertilizing element contained or claimed to be contained therein. It is provided, however, that if the manufacturer

or "importer" has already paid one fee for all of his agents in the State, they are then relieved from the payment of the same.

Parties desiring to purchase small quantities of particular brands not on sale within the State, may buy them outside of the State *for their own use and not to resell,* without subjecting themselves or the manufacturers to the payment of a fee. Owing to this provision for small purchases direct from manufacturers, dealers or manufacturers cannot be excused from the payment of fees upon the plea of small sales of particular brands.

All agents in the State, before undertaking the sale of any fertilizing materials covered by the provision of the law, should first assure themselves that the manufacturer or importer has paid a fee for them. If dealers have not a copy of the fertilizer law they may procure one upon application to the Secretary of the State Board of Agriculture, Providence, R. I., or to this Station.

ANALYSES OF FERTILIZERS COMPOUNDED ACCORDING TO SPECIAL FORMULAS.

No. 237. Sample sent by Seth Anthony, Portsmouth, R. I.
No. 238. Sample sent by E. G. Macomber, Portsmouth, R. I.

	No. 237. Per cent.	No. 238. Per cent.
Nitrogen in nitrates	1.26	1.71
Nitrogen in ammonium salts	.00	.00
Nitrogen in organic matter	1.98	3.01
Total nitrogen	3.24	4.72
Soluble phosphoric acid	6.20	3.02
Reverted " "	1.91	2.54
Available " "	8.11	5.56
Insoluble " "	2.87	3.60
Total " "	10.98	9.16
Potash	9.36	11.22
Chlorin	*	5.20
Commercial valuation	$27 24	$30 88

MR. ANTHONY'S FORMULA.

	lbs.
Nitrate of soda	150
Dry ground fish	200
Bone tankage	400
Dissolved boneblack	900
Muriate of potash	350
	2,000

* Chlorin more than equivalent to the potash.

MR. MACOMBER'S FORMULA.

	lbs.
Fine ground bone	400
Dissolved boneblack	400
Dry ground fish	300
Cotton-seed meal	300
Nitrate of soda	200
Sulfate of potash	200
Muriate of potash	200
	2,000

Mr. Macomber had estimated the composition of this fertilizer from the probable composition of the materials used, and writes in relation to the same as follows: "Comparing my estimate of the percentage of each element with the result obtained by analyses at the Experiment Station, I find that the mixed goods analyze considerably in excess in each element above my estimate, showing, so far as one sample can prove, that the goods purchased are as guaranteed as a whole, and that the mixture has been complete." This is the experience of Mr. Macomber, in spite of the fact that many manufacturers state that farmers cannot mix goods with sufficient uniformity.

No. 239. Mixture "A" from Portsmouth Grange.
No. 240. Mixture "B" from Portsmouth Grange.
No. 241. Mixture "C" from Portsmouth Grange.

	No. 239 "A." Per cent.	No. 240 "B." Per cent.	No. 241 "C." Per cent.
Nitrogen in nitrates	.90	.94	.96
Nitrogen in ammonium salts	.00	.00	.00
Nitrogen in organic matter	2.45	2.76	2.66
Total nitrogen	3.35	3.70	3.62
Soluble phosphoric acid	5.19	5.78	5.56
Reverted " "	2.86	2.77	2.58
Available " "	8.05	8.55	8.14
Insoluble " "	2.57	2.50	2.64
Total " "	10.62	11.05	10.78
Potash	9.84	8.68	7.97
Chlorin	5.70	5.40	5.60
Commercial valuation	$27 97	$28 36	$27 03

These goods were purchased at a price which in every instance was less than the commercial valuation, while those farmers who

bought the *low-grade fertilizers such as were retailed generally throughout the State* paid from ten to fifteen dollars per ton for them in excess of their valuation. We are credibly informed that these goods have given almost universal satisfaction, and many reports have been made to the effect that they showed results usually better than the best high-grade mixed goods on the market.

If the farmers of the State all showed the same business enterprise which has characterized the Portsmouth Grange, they would not long continue to buy their fertilizers in the same costly manner employed in the past.

The following are the formulas according to which the goods for the Portsmouth Grange were mixed :

	A	B	C
	lbs.	lbs.	lbs.
Nitrate of soda	100	100	125
Dried blood	50	100	..
High grade tankage	650	600	500
Dried fish	..	..	200
Dissolved boneblack	..	400	160
Acid phosphate (dis. phosphate rock)	806	450	700
High grade sulfate of potash	194	150	100
Muriate of potash	200	200	215
	2,000	2,000	2,000

The goods mixed according to the formulas employed by the Grange the first season caked somewhat, which interfered with their easy application, particularly by machinery. The above formulas, however, have been reported to have yielded a mixture which did not cake and was in excellent mechanical condition.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 43.

GARDEN SEEDS IN RHODE ISLAND.

ADDITIONAL FACTS RELATING TO THEIR QUALITY.

L. F. KINNEY AND G. E. ADAMS.

It was shown in Bulletin 35 of this Station that garden seeds are sometimes offered for sale which are not fit for planting purposes. Among 233 samples of such seeds that were collected systematically from thirteen different seedsmen and dealers in the spring of 1895, twenty were found where there were three or more poor seeds for every good one, and there were twenty-three other samples that were composed of one-half or more poor seeds. These samples were of popular varieties of vegetables, and they were purchased during the planting season, consequently it is supposed that they formed a fairly representative collection, and that the results of their examination are worthy of consideration.

151 More Samples Collected and Examined.

The vitality of thirty-four of these lots, as shown by germination tests, fell below fifty per cent. That is, a purchaser in buying seed of these kinds would receive in most cases less than one-

half his money's worth of growable seed. Exceptional precautions were taken this year to guard against any possible inaccuracy in the results of the germination tests. The number of seeds used in each test was increased from one to two hundred, and in addition to making duplicate tests in the sprouting cups, earth tests were conducted in each case.

A SAMPLE DOZEN RESULTS OF THE TESTS.

Station Number.		In Cups.			In Earth.		
314	Boston Curled Luttuce.......	4	pr. ct.	germinable.	1	pr. ct.	germinable.
446	Sweet Mountain Pepper......	9	"	"	9	"	"
374	Squash Pepper..............	10	"	"	6	"	"
390	Yellow Globe Onion.........	15	"	"	12	"	"
319	Thick Leaved Spinach.......	17	"	"	15	"	"
357	White Plume Celery.........	21	"	"	20	"	"
428	Thick Leaved Spinach.......	23	"	"	25	"	"
339	White Crown Parsnip........	27	"	"	26	"	"
318	Early Scarlet Turnip Radish..	30	"	"	16	"	"
426	White Bush Scollop Squash..	36	"	"	36	"	"
447	Acme Tomato....	36	"	"	21	"	"
364	Emerald Gem Muskmelon....	48	"	"	40	"	"

RESULTS OF ANOTHER DOZEN GERMINATION TESTS.

Station Number.		In Cups.			In Earth.		
394	Hanson Lettuce..	98	pr. ct.	germinable.	96	pr. ct.	germinable.
379	Hanson Lettuce.............	94	"	"	87	"	"
363	Squash Pepper.....	74	"	"	71	"	"
405	Yellow Danvers Onion.......	93	"	"	86	"	"
419	Giant Pascal Celery..........	83	"	"	85	"	"
410	Golden Self Blanching Celery	79	"	"	76	"	"
393	Hollow Crown Parsnip	76	"	"	76	"	"
341	Scarlet Turnip Radish	94	"	"	94	"	"
356	Long Scarlet Radish	93	"	"	89	"	"
370	White Bush Scallop Squash..	84	"	"	84	"	"
375	Acme Tomato...............	95	"	"	81	"	"
337	Nutmeg Muskmelon.........	98	"	"	89	"	"

The faults of gardeners may be many and the soil may occasionally be too wet or too dry or the atmosphere too hot or too cold, yet were these matters entirely eliminated from consideration it would require greater powers of penetration than the ordinary human mind is accredited with, to know just how thick to sow

seed, the vitality of which is so exceeding variable as the onion, parsnip and radish, tested, in order to have the ground uniformly covered with plants without a lot of extra ones to be weeded out. Every gardener of experience knows that too many plants are as disastrous to a crop as too few, and that to secure a maximum yield there must be approximately a definite number.

Suspicious Cases.

Among the 151 lots examined there were twenty-three cases where the same variety was collected this year from the same dealer or seedsman as last, and as the methods and germination apparatus were the same each season, and furthermore, as the details of the work were performed by the same person, the results of the two years' tests of these seeds are directly comparable.

Ten samples out of the twenty-three showed a decidedly lower vitality this year than last. We do not know that we bought, in these cases, seeds from the same lots the two years in succession, but as garden seeds which are not sold one year are sometimes kept over and sold the next, some of these at least may have been from last year's stock.

The results of the germination tests for the two years were as follows:

	Per cent. germinable. 1895.	Per Cent. germinable. 1896.
Onion Seed.		
Yellow Globe Danvers	92	43
" " "	82	57
" " "	76	15
Pepper Seed.		
Sweet Mountain	79	30
Bull Nose	66	37
Sweet Mountain	60	38
" "	48	9
Tomato Seed.		
Dwarf Champion	98	87
Cucumber Seed.		
White Spine	96	82
Carrot Seed.		
Danvers	94	32

If the supposition that garden seeds are occasionally sold year after year until their vitality becomes very low is correct, then we should expect to find ascending as well as descending series of cases, indicating either that new seed had been mixed with the old or a sudden change from old to fresh stock. If new seed is mixed with old the vitality of the stock may appear to improve with age, but it is not to be presumed that it could ever become by this process quite as good as high grade fresh seed. We found four cases that may be used to illustrate the case in point, although of course we know nothing about the history of the seeds other than what could be learned from the samples examined. It is evident in these cases that we were not supplied with seeds from exactly the same lots this year as last, but still the low vitality of the samples and other things that were noted during the tests indicate that there were old seeds in both samples. The results of the germination tests were as follows:

	Per cent. germinated. 1895.	Per cent. germinated. 1896.
Yellow Globe Onion	41	58
" " "	60	77
Sweet Mountain Pepper	64	69
Hollow Crown Parsnip	32	60

We have heard it said among gardeners, that if very poor seed is obtained from a dealer one year it is reasonably safe to place an order for the same kind of seed with that dealer the following year, on the supposition that his stock will be sold out and he will have a new lot, and we are not sure that such reasoning is entirely without foundation.

It should be noted here that the dealer who handles only a limited amount of seed is exposed to imposition in the same way as the gardener and, therefore, that it does not necessarily cast any reflections upon his integrity if he occasionally happens to get a poor lot of seed. He may conscientiously destroy at the end of each season all seeds that he has on hand, and then in making his purchases of stock for the following spring's sale he may get seeds from the same lots again, that have been "held over," mixed or adulterated in store houses, perhaps thousands of miles away.

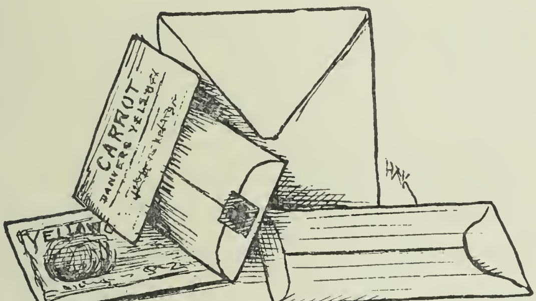
Bulletin 43. January, 1897.

KINGSTON, RHODE ISLAND.

ADDITIONAL TESTS

OF

GARDEN SEEDS.



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Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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† Five-sixths of time devoted to college work.

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SECOND TESTS OF SIXTY SAMPLES.

In order to show that the vitality of garden seeds often deteriorates more rapidly than those who handle them realize, second tests were made of five samples of each of twelve kinds, after they had been stored in a dry upper room four months in the original packages in which they were bought. It is probable that some allowance should be made for the fact that there was but a comparatively small quantity of a kind in a package, but other than this the conditions under which they were kept were not unlike those to which such seeds are subject when carried in stock by store keepers. The results of these tests clearly indicate one thing at least, viz.: That too much should not be taken for granted concerning the vitality of seeds when they are kept in this way. Some samples showed nearly or quite as high a percentage of germination after being kept as before, while the cultural value of others depreciated so much that they were not worth planting four months after they were purchased. In view of these facts it is probable that dealers who do not have facilities for testing their seeds systematically often misjudge their condition, and occasionally sell a poor lot of seeds when they suppose the quality of their stock is unquestionable. If tomato plants dry up and die in the store they do so at the grower's or dealer's loss, consequently great care is exercised to preserve their vitality, but it is not always so with vegetable seeds; if they dry up and die prematurely, while waiting for a customer to present himself, the grower may get his pay for them just the same, and the dealer may likewise fare as well, but in this case it is the gardener who pays the forfeit. He not only loses the money that he pays for the seed, but in addition to this the value of the use of land, fertilizer and labor that is wasted in trying to get a crop from non-growable seed.

Table showing results of germination tests made in April and May, and again from the same packages in August and September of the same year.

Station Number.		Per cent. germinated at end of fourth day.		Per cent. germinated at end of fourteenth day.		Days required for 50 per cent. of sample to germinate.	
		First test.	Second test.	First test.	Second test.	First test.	Second test.
	CABBAGE.						
344	Flat Dutch..	90	89	93	90	2	2
386	Premium Flat Dutch..........	92	72	97	77	3	3
387	Premium Flat Dutch..........	92	81	98	84	2	3
407	Flat Dutch....................	17	39	53	52	12	7
415	Flat Dutch....................	88	88	91	91	2	2
	CARROT.						
300	Long Orange..........	58	36	74	60	4	6
334	Long Orange................	37	35	63	56	5	6
345	Long Orange..................	51	33	63	53	4	6
367	Long Orange..................	49	47	63	59	5	5
391	Long Orange..................	50	54	62	61	4	4
	CELERY.						
333	Boston Market.................	0	0	61	37	11	......
357	White Plume.........	0	0	21	3	.....	......
362	Giant Pascal..................	0	0	69	31	10	......
397	Giant Pascal..................	0	0	46	5	......	......
419	Giant Pascal	0	0	83	68	10	11
	CUCUMBER.						
361	Early Frame..	62	59	66	60	2	2
380	Early Frame......	89	86	89	87	2	2
400	Early Frame..................	86	84	87	85	2	2
418	Early Frame..................	71	76	76	76	2	2
430	Early Russian........	71	72	72	72	2	2

Table showing results of germination tests.—Continued.

Station Number.		Per cent. germinated at end of fourth day.		Per cent. germinated at end of fourteenth day.		Days required for 50 per cent. of sample to germinate.	
		First test.	Second test.	First test.	Second test.	First test	Second test.
	LETTUCE.						
314	Boston Curled	4	0	4	0	......	......
336	Curled Silesia	83	64	94	93	3	4
379	Hanson	87	94	94	94	3	2
417	Hanson	87	82	90	86	2	2
436	Simpson	65	79	82	82	3	2
	ONION.						
338	Yellow Globe	61	78	82	82	3	3
360	Yellow Danvers	33	14	43	17	......	......
390	Yellow Globe	11	3	15	3	......	......
437	Yellow Globe	29	47	58	49	9	......
445	Yellow Danvers	42	54	57	56	8	3
	PARSNIP.						
368	Hollow Crown	0	0	54	53	12	12
377	Hollow Crown	2	0	72	63	8	9
393	Hollow Crown	0	0	76	69	9	10
412	Hollow Crown	0	0	37	12	......	......
422	Hollow Crown	0	0	60	57	14	11
	PEPPER.						
363	Squash	1	0	74	61	11	8
399	Squash	0	0	6	2	......	......
402	Bull Nose	4	0	37	36	......	......
421	Sweet Mountain	7	0	69	59	9	6
429	Sweet Mountain	0	0	38	35	.....	......

Table showing results of germination tests.—Continued.

Station Number.		Per cent. germinated at end of fourth day.		Per cent. germinated at end of fourteenth day.		Days required for 50 per cent. of sample to germinate.	
		First test.	Second test.	First test.	Second test.	First test.	Second test.
	RADISH.						
349	Long Scarlet..................	66	75	84	75	3	2
365	Long Scarlet................	70	58	85	60	3	3
373	Long Scarlet................	65	65	84	66	3	2
398	Long Scarlet..................	75	81	85	81	2	1
403	Long Scarlet................	32	59	69	60	5	3
	SPINACH.						
327	Long Standing................	3	7	34	17	......	.....
350	Bloomsdale..................	19	15	42	22	......	......
383	Bloomsdale................	19	9	35	33	......	......
395	Bloomsdale................	13	1	38	22	......	.....
424	Bloomsdale..................	0	2	23	23	......	......
	SQUASH.						
370	White Bush..................	83	39	84	83	3	5
382	White Bush Scallop..........	27	5	40	29	......	......
389	White Bush..............	80	47	85	84	3	5
404	White Bush Scallop.........	67	17	75	61	4	7
426	White Bush Scallop...........	29	5	36	35	.....	......
	TOMATO.						
366	Acme........................	83	74	94	91	3	4
375	Acme....................	92	90	95	95	3	4
388	Dwarf Champion............	68	62	87	72	4	4
406	Acme........................	74	59	89	79	4	4
427	Acme........................	88	92	93	92	3	3

The results of the tests may be briefly summed up as follows: In eight samples the percentage of germination was the same in both tests. It was one per cent. lower in the second test in ten samples, two per cent. lower in the second test in four samples, three per cent. lower in the second test in five samples, and four per cent. lower in the second test in three samples, or there was a variation of less than five per cent. in the results of the two tests of thirty samples—one-half the number included in these tests. There was, however, much more difference between the results of the tests of the other thirty samples. In one-third of these the variation between the results of the two tests did not exceed ten per cent., in eight other cases it did not exceed fifteen per cent., in nine cases it did not exceed twenty-five per cent., in one case it was twenty-six per cent., and in two cases it was more than thirty-five per cent.

The kinds included among the thirty samples where the variations between the results of the two tests were less than five per cent. were:

Lettuce	5 samples.	Parsnip	2 samples.
Cucumber	4 "	Onion	2 "
Cabbage	3 "	Carrot	2 "
Squash	3 "	Spinach	2 "
Tomato	3 "	Radish	1 "
Pepper	3 "		

The kinds included among the seventeen samples where there was a variation of fourteen per cent. or more in the results of the two tests were:

Celery	5 samples.	Onion	1 sample.
Spinach	3 "	Parsnip	1 "
Cabbage	2 "	Squash	1 "
Radish	2 "	Tomato	1 "
Carrot	1 "		

Thus it appears that while one-half of the samples that were tested a second time showed comparatively little deterioration in their vitality, there were other samples of the same kinds of seed which, although kept apparently under similar conditions, lost their vitality much more rapidly. While we may not be able to satisfactorily explain why this should occur, yet knowing that it is a peculiarity of seeds to do so is an additional reason why

seedsmen should base their information regarding their seeds upon actual test rather than give them the benefit of the doubt when questions arise concerning their vitality.

With the present struggle that is going on among gardeners to keep the balance of their accounts on the right side, that is, to keep the cost of production below the market value of the crops, the yield per given area of land becomes an important matter for consideration. Now it is well known that the use of seed of low vitality tends to curtail the yield of a crop, because the entire area of the ground is not utilized by it, and also that it often takes crops from such seeds several days longer to mature on account of lack of vigor of the young plants. These two things alone may so influence the receipts from a crop that they will not be sufficient to meet the expense of growing it.

GUARANTY OF VITALITY.

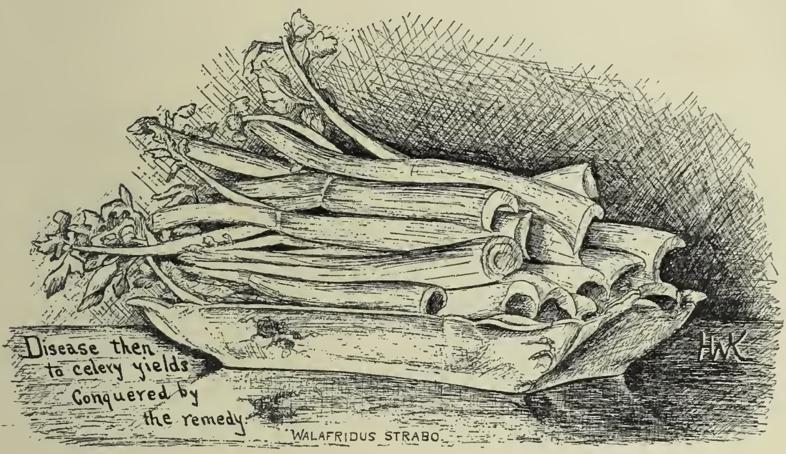
Inasmuch as the fate of a crop of vegetables in a measure depends upon the vitality of the seed planted, it is apparent that by the present practice of using seed of variable and uncertain vitality the difficulties in keeping the cost of cultivation below the market value of the crop are increased. This is because a shrinkage in the yield of a crop is not usually accompanied by a proportional reduction in the cost of growing it. It therefore appears that the practice is both irrational and imprudent, and a proper subject for discussion in reviewing the ins and outs of the cultivation of vegetables. The trouble seems to be in the fact that the purchaser needs some assurance that seed is fresh and has been properly kept, other than its occurrence in any particular dealer's stock. He wants to know how many carats fine it is before he places too much confidence in it. Dealers on the other hand are inclined to look askance at any suggestions about making definite statements concerning the vitality of their seeds, particularly, perhaps, because they feel that there is danger of such statements being wrongly construed, and as a result their being liable for damage for which they are in no wise responsible. Now the solution of the matter seems to lie in the perfection of some arrangement between gardeners and dealers by which the latter will regularly and systematically test their seeds, when in bulk, and furnish each purchaser a statement of the result of the test of such seeds

as they happen to buy. The tests should be made by approved methods, and the statement of the result truthful. This would supply what the purchaser of the seeds ought to know before planting them. It need not materially increase the price of seeds, and there is no lack of evidence to show that the adoption of some plan of this kind would tend, indirectly, to increase the products from Rhode Island soil. There is a multitude of purchasers of garden seeds who would be directly benefited, and it is upon them that the burden of adjusting the arrangement must fall, because the benefits that will accrue to dealers are less apparent, and consequently they take less interest in the matter.

Bulletin 44. March, 1897.

KINGSTON, RHODE ISLAND.

CELERY.



Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 44.

CELERY CULTURE IN RHODE ISLAND.

L. F. KINNEY.

The simplest operations connected with the cultivation of vegetables are not usually the most profitable. There is a reward here as in other occupations for those who are capable of performing difficult tasks, who have the necessary ability to overcome apparent obstacles and produce something, whether a cucumber or a head of celery, which the market demands, at a price above what it has cost to grow it. In doing this a trifle is added to the wealth of the community in which the business is conducted, and theoretically the capital invested in the business should be slightly increased. But it is the difference between the cost of a crop and the price that it will bring after it is grown that measures the amount of wealth which is originated in the operation, and not the total number of bushels or even the utility of the crop. It follows then that market gardening is nothing more nor less that a series of efforts to increase the price of certain crude materials by making them over into this or that finished product, with the supposition that the product will sell for more than it cost.

Perhaps in no other State in the Union is there relatively such a large local demand for home grown garden vegetables as here in Rhode Island, and this has a powerful influence to foster their cultivation simply because they bring the producer a better price

than they would if transportation and commission charges had first to be deducted. It has been thoroughly demonstrated that celery of the best quality can be grown here, and furthermore as a crop it has proved a good money maker—as crops go. That is, the price of celery has probably rather exceeded the average cost of raising it, and in exceptional cases it is evident that considerable profit has been derived from its cultivation. The large shipments from Kalamazoo and other celery growing districts in Michigan, have shown the possibilities of our markets. This has encouraged local growers and efforts are now being made in every part of the State to grow this vegetable. It is, however, one of the choice products of the gardener's art and when in perfection it must always stand for a high grade of workmanship.

LEVEL *vs.* TRENCH CULTURE.

The custom of setting celery plants below the level of the ground in trenches was introduced into this country long ago, and probably from England. It was the usual method practiced by gardeners until about 1850 and it still has its advocates, among whom may be mentioned the excellent authority on celery culture Mr. W. N. Craig,[1] of Taunton, Mass., but about the middle of the present century celery culture grew to be an important industry, particularly in the vicinity of New York, and the active competition which resulted forced growers to simplify the operations involved as much as possible, and the outgrowth of this was the adoption of what is called "level culture," and now the trench method is almost forgotten. The trench method is essentially this: trenches are dug three or four feet apart, six inches or more in depth, and a foot or more in width with perpendicular sides; from two to four inches of decomposed stable manure and perhaps some concentrated special fertilizer are thoroughly worked into the soil at the bottom. Sometimes one and sometimes two rows of celery are set in a trench and when the plants are large enough the earth that was thrown out is thrown back again and used for banking, or more recently the blanching is done with boards as in level cultivation. Inconveniences beset the work of growing celery by this method on every side, yet the method itself possessed some peculiar advantages. *First,* it invariably provided a

[1] Garden and Forest, Vol. IX, p. 286.

very rich soil for the plants to grow in. *Second*, the plants being below the surface of the ground, any surplus water in the soil

FIG. 1. Market Scene, Providence, October 26, 1896.
"As we stood on the bridge at—sunrise."

naturally gravitated toward them. *Third*, the roots of the plants were slightly protected from the burning heat of the mid-day sun. Now it was found that with level culture the soil could be made rich enough, and also that the plants could be supplied artificially with water; but to provide the third condition, viz.: to keep the temperature of the soil about the plants from rising too high during hot spells in summer has always been an unsolved problem to celery growers not having peculiarly cool soils, since the level culture method was adopted; and it seems at least probable that the cause of the most serious profit-shaving troubles that celery growers have to contend with at the present time can be traced to improper care concerning this important matter. Our attention was first attracted to it while studying the growth of the different varieties last season.

BLACK-HEART, BLIGHTS AND BLAST.

The disorders that are known among celery growers by these names all appeared in our field of about five thousand plants. Here were all kinds growing together, raised from over one hun-

dred different lots of seed, some of them surface-irrigated, some sub-irrigated, and some not irrigated at all. In some rows the plants were six inches apart, in others twelve and in still others they were eighteen; and again, some of the plants were heavily and frequently drenched with the Bordeaux mixture and some were not. Some grew in soil that had produced celery afflicted with the same diseases the preceding year and where the litter had been left upon the ground to decay, and some in other sections of the field where celery plants had never grown before.

First. Were the troubles peculiar to any particular varieties? Apparently not, although some kinds were injured more by them than others.

Second. Did the spores or germs come with the seeds and the disorders develop with the plants? We could discover no indication that such was the case. There was no conspicuous difference in the prevalence of the diseases on the plants that were grown from duplicate lots of the same variety which were obtained from various sections of the United States and Canada.

Third. It is supposed by some growers that excessive drouth at some time is the initial cause of the troubles, but in the irrigated sections of our field the soil was never dry to any considerable depth and yet the plants in those sections were not exempt from either the black-heart or blight.

Fourth. All land without considerable clay in the sub-soil is supposed by some growers to be disqualified for the cultivation of celery, because it is thought that these disorders are more prevalent on such land. This belief appears to be well founded, although we are inclined to think that the clay in itself is not an important factor in celery culture, for there is more trouble experienced in growing the crop on clay land, which dries out in summer, than upon ordinary garden loam.

Fifth. The Bordeaux mixture seemed to check the multiplication of the characteristic blight spots upon the leaves, but it did not preserve the normal vigor of the plants during the hot spells in August. The color in the older leaves faded if they did not blight, and later when the weather became cool and the mixture was washed from the leaves no one could tell by appearances which rows had been treated and which had not.

Sixth. Neither the black-heart nor blight were any more prevalent where celery had been grown than where it had not, and we found no proof that the troubles were particularly contagious, although probably either of them could be readily communicated from plant to plant under favorable conditions. When artificial inoculations were made, however, only local injuries resulted, the diseases did not spread in healthy tissues enough to seriously enfeeble vigorous plants. Where, then, are we to locate the starting point of these disorders?

FIG. 2. Celery plants showing the condition known as "Black Heart," one of the most serious impediments to successful celery culture.

HIGH TEMPERATURE.

In some way there must be a relation between these disorders and hot weather because they always appear in their most violent form either during or soon after a period of high temperature; but high atmospheric temperature does not always prove disastrous to celery plants, for it seems that they can not only endure it but they can thrive in it.

A COOL SOIL.

FIG. 3. Celery leaf attacked by a common form of "Blight," and a magnified section of one of the diseased spots.

Probably the leaves of celery plants can perform their functions in an atmosphere with a high temperature, provided that the soil about their roots is moist and cool, but with level culture no special effort is made to secure this latter condition, except by the frequent application of water. It is well known that the bulk of the roots of a celery plant are formed in a mass directly at its base, and that the roots come quite to the surface of the soil about the plant if they are permitted to do so; consequently a large proportion of them are exposed to the fluctuation in temperature to which the

first two or three inches of surface soil is subject. The artificial application of water tends to reduce the temperature of the surface soil in two ways, (1) because the temperature of the water applied is usually lower than that of the soil, and (2) by moistening the top layers so that evaporation is increased. This practice alone is faulty in that the influence which the water has upon the temperature of the soil is temporary or only automatic in a slight degree. As soon as it is gone the temperature will rise again and this rise will begin, where the soil is a little porous and the atmosphere hot and clear, before the man who applied the water has turned his back upon the field.

A COVER FOR THE ROOTS.

There appears to have been a design in the old trench method of cultivating celery, to place the roots of the plants out of reach of the burning rays of the sun, but we do not find any provision for this in the newer "level culture" of celery. The plants are now lined up on the surface and made to toe the mark like other vegetables. This works very well except in periods of high temperature; then the roots of the plants need additional covering which the level-culture and board-blanching method does not provide, and apparently as a consequence of this the disorders known as the black-heart and blights appear from time to time. The following evidence is cited in support of the belief that such is the case: (*a*) When a mulch of fresh sea-weed two incher thick was placed about celery plants showing these diseases it checked the progress of the troubles. (*b*) A similar result was obtained by mulching the plants with two inches of earth from the centre of the rows and then filling the ditches with fresh sea-weed and turning water into them occasionally to keep the sea-weed moist. (*c*) Plants that were blighting badly actually improved when heavily mulched with leaves from other blighted plants—which must have been teeming with spores of the disease. (*d*) Plants were noticeably benefited by being mulched with lawn clippings and also with meadow hay when watered as before the mulches were applied. (*e*) Coarse stable manure was beneficial when placed around the plants as a mulch and kept moist by frequent watering. (*f*) Partial "earthing up" before extreme hot weather came on

appeared to have entirely protected, from the blight, one small patch of early Paris Golden celery that came under our notice, and this was not on naturally cool land, neither was it artificially watered. (*g*) The blight were noticeably more prevalent on Paris Golden celery plants which stood eighteen inches apart in the rows, allowing the sunlight to strike the ground all about them, than where they were but six inches apart and made a thick mat of foliage. (*h*) The varieties noted as showing the most blight and black-heart during the season were among those having leaves that shaded the ground the least, viz.: Sandringham, Crimson and Paris Golden. (*i*) Celery plants set in beds seem to be less subject to the blight and black-heart when they are properly fed and watered than when they are set in rows and the ground about them exposed to sunlight. (*j*) Celery plants growing in the shade of trees are not as likely to blight as those in the open field, if the soil is equally fertile and moist, but they usually become feeble on account of lack of sunlight. (*k*) Finally, when celery plants are set in properly prepared trenches and two or three inches of soil drawn in over their roots upon the approach of hot weather, there is no serious trouble from these diseases if the trenches always

FIG. 4. Paris Golden Celery as grown in beds; plants 8 inches apart each way, with plank in place to complete the blanching process.[1]

have an adequate supply of water. Of course it is understood that the lack of proper protection of the roots of celery plants is not the

[1] View in market gardens of W. W. Rawson, Arlington, Mass., September 12, 1896.

sole cause of all celery diseases, nevertheless this seems to be the principal fault of the "level culture" method as it is now practiced in its highest form. There are two ways of correcting this fault, viz.: either by carrying the roots farther below the natural surface of the soil by setting the plants in shallow furrows and drawing the earth in about them as they grow, or by raising the surface of the soil along the rows by "hilling" the plants, or by mulching them. We are aware that there are recognized objections to marring in any way the simplicity of the level culture method of growing celery, yet it may be necessary to do it in order to protect the crop from the frequent and harassing attacks of these dreaded diseases.

Hollow Stalks.

Celery growers have been familiar with hollow stalked celery ever since this vegetable was introduced into the gardens of Europe, and it is still the cause of frequent complaint and sometimes of serious financial loss, although probably less trouble is experienced from it now than there was forty years or more ago. The names of the earlier varieties suggest that growers then considered the solidity of the stalks an important quality; there was the Red Solid, the White Solid, the Crystal White Solid, Late White Solid, the Incomparable Dwarf Solid, etc. Now it is understood that all of the modern varieties have solid stalks normally, nevertheless plants with pithy stalks occasionally occur in all fields; perhaps they are more common in some varieties than others although we do not know that any kind is entirely free from them. It is probably an hereditary trait, and where there are many plants of this kind it is generally inferred that the seed was from poor stock; still the condition of the soil may make some difference.

Varieties.

A canvas of the seed market last spring brought us celery and celeriac seed under fifty-nine different names. These seeds, together with nearly as many more duplicate lots, were planted to provide material for a systematic study of the varieties, the chief object being to note the successive steps in the onward march of the species to a higher domesticated state. Included in the col-

lection were the principal varieties of celery which have been cultivated in this country during the past fifty years. Doubtless the older kinds have been slightly modified, but probably not enough to lose their identity. In the absence of accurate descriptions or

FIG. 5. The approved type of Boston Market celery about 30 years ago.[1]

herbarium specimens, it is fortunate that we are able to turn the leaves of time backward and thus compare the celery of half a century ago with that of the present time, for it is not enough to know that we have new varieties that are better than the old; we want to know along just what lines the improvements have been

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[1] From Tilden's Journal of Horticulture, Vol. V. p. 277. Reduced.

made which have endured in the long run. To the systematic botanist the garden celery of to-day may be essentially the same as that of fifty years ago, but to the horticulturist it is vastly changed. Supposing that a commercial grower should take the advice given by a correspondent to the *New England Farmer*,[1] in 1853, which was "When you go to buy celery seed ask for Seymour's Superb," and attempt to grow this in competition with the Paris Golden. He would be laughing stock for the town, and yet the inflorescence of the two varieties may be similar, the leaves may be divided into the same number of parts and even the differences in venation and serration of the leaflets may be hardly discernible. As a matter of fact, a slight varietal peculiarity of a plant, that is cultivated on a large scale, may appear when projected on the balance sheet of the profit and loss account at the end of the season, like a stereopticon picture, much larger than the original. The markets demand, according to the judgment of the people who buy in them, a first class article, and the variety that will supply this product with the least cost is the best one for the grower to raise; consequently here is where the great competition between cultivated varieties is manifest. There has been no remarkable improvement in the flavor of celery or increase in the size of the stalks during the period under consideration, but there has been a wonderful adaptation of the varieties to garden culture. Like machines that have been perfected, celery plants at the present time release much of the labor that was formerly required in the production of this crop. The blanching of the leaves and leaf-stalks of the older varieties was a difficult task, but in the leading sorts of the last decade this goes on naturally as a kind of ripening process after the plants are mature, and it is not unusual to see a Plume celery plant as white as a Mountain of Snow geranium, without artificial blanching, but the flavor of the stalks still has to be refined by artificial means. Again, the earlier varieties of celery were tall growing plants, with long and unwieldly outside leaf stalks and rather open crowns, consequently they required relatively a large space in the field to produce a small amount of edible matter. In contrast with such kinds we have the Paris Golden of the present time, which is wonderfully compact in habit of growth and capable of producing perhaps as much edible matter with one-half the

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[1] Vol. 5, p. 59.

space in the field and in less time. Even with the Giant Pascal, which is a tall growing kind, the main growth takes place in the central portion of the plants, but this kind is too large and tall to ever become a general favorite with growers except for a fancy market. There were red varieties of celery in cultivation fifty years ago, and we have them still, but they are not now and have never been as popular as the white; superior flavor and keeping qualities have often been claimed for them, but we have found very little evidence to support such claims. Observations lead us to believe on the contrary that the average quality of the red and pink varieties of celery now grown in this country is not as good as the average quality of the white varieties and that their keeping qualities are no better.

Comparatively few of the many varieties of celery that have been introduced to American celery growers during the last fifty years have exerted any lasting influence upon celery culture as an industry, and these are varieties that have come along from time to time and won temporary popularity among growers because they have yielded a product which has satisfied the demands of the market at a considerably less cost than any preceding or contemporary variety would under similar conditions. The period of a variety's popularity generally lasts until the species takes another decided step in advance and throws out a new variety with qualities better adapted to garden culture than those of any that has preceded it. In this way the popularity of a variety rises and falls, but this popularity has more than a passing interest to the student of horticulture, because it points out to him the zig-zag line that is traversed by a cultivated crop so far as it is affected by varietal modifications during a given period. It has already been said that the leading varieties of celery at the present time differ from those of half a century ago in greater localization of the fleshy growth in the centre of the plants, in self-blanching tendencies and in earlier maturity. The most important varietal modifications that appeared during the transition seem to be embodied in the following varieties of which illustrations are given. Many other kinds were cultivated during this time but so far as we can learn they have had only an indifferent influence on the economics of celery culture and consequently they are of relatively little interest to growers.

All varieties of the cultivated celery are forms of *Apium graveolens L.*, which is found growing wild in England and elsewhere

over a wide range of country. So far as we can learn there has been no intermingling of species in the improvement of this vegetable. Apparently it was induced to depart gradually from the natural type solely by cultivation and selection until distinct varieties became established, and then cross fertilization began to occur. This gave rise to intermediate forms and now that the varieties have departed farther from each other cross fertilization has become a common means of obtaining new kinds. The variation that results from the crossing of varieties is less erratic than that which occurs when true hybrids are formed; consequently there is greater stability of type among cultivated plants that have originated from a single species, than where several species have intermixed. A study of the varieties of celery well illustrates how gradually changes take place in succeeding generations of a vegetable originally derived from one species.

FINE-LEAVED SOUP CELERY.

Description: leaf-stalks below the lower pair of leaflets long, often eighteen inches, about one and a half inches in circumference, hollow, with seven distinct ridges on the outside and eleven bundles; furrow in front side of stalk shallow. Upper portion of leaves twelve to fifteen inches long, leaflets small. Plants large and spreading with numerous secondary crowns at the base. Root fibrous.

A poorly defined type that was occasionally grown fifty years ago, particularly for flavoring soups, etc. It has hollow leaf-stalks which were more common among the different varieties of celery then than now, and it is strongly aromatic. It does not represent the celery that was generally grown at that time for market which was occasionally mentioned as the White Solid and the Red Solid, although it is probable that these also were not well-defined varieties. Writers at that time evidently did not consider the varietal difference in celery very important. Seymour's Superb seems to have been an improved White Solid, but like it large and coarse with heavy foliage. The outer stalks were not generally blanched, but the inner ones were probably crisp and of rich flavor. A correspondent to the *New England Farmer*[1] wrote, in 1853, as follows: "I have bought what is called White Solid (celery) but this is a great misnomer for it is as hollow as a pumpkin stalk and not much better for eating," probably was supplied with soup celery instead of White Solid as he supposed.

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[1] Vol. V, p. 59.

FIG. 6. Fine-leaved Soup Celery. Leaf-stalks hollow.
Plant about 2 feet 6 inches high.

SANDRINGHAM OR INCOMPARABLE.

Description: leaf-stalks spreading but little below the lower part of leaflets, eight to ten inches long, about two inches in circumference, deep green, with seven distinct ridges and as many conspicuous bundles embedded in green cells. Besides these there are four smaller bundles in the edges of the stalks. Furrow in front of stalks three-eighths of an inch wide. There is no constriction of the stalk where the first pair of leaflets form although the upper portion projects over the lower portion of the stalk slightly. The leaf-bearing portion above as long, or nearly as long, as the stalk below, leafy. Leaflets large, coarsely serrate and with faint metallic hue; branches of the leaf stalks slender. Plants without secondary crowns, slightly turnip-rooted, upright, with leaflets in a bunch at the top. Plants especially subject to the blight when grown by modern methods. Perhaps an explanation for this can be found in the fact that the leaves furnish very little shade for the roots.

An old variety of rare merit. It seems to have been named Incomparable by the *Fruitist and Florist* in 1853 or 1854, which stated at that time that "the raiser of this useful variety is unknown."[1] It was highly prized by growers in Buckingham Co., England, forty-five or fifty years ago, and it may have originated in that locality. It was one of the first varieties extensively grown about New York, and in 1871 P. T. Quinn writes[2] "that it is in all respects the best variety for field or garden culture.

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[1] American Agriculturist, Vol. XII, p. 7. (March, 1854).

[2] Money in the Garden, p. 123.

FIG. 7. Sandringham or Incomparable Celery. A popular variety 30 or 40 years ago.
Plant about 2 feet high.

BOSTON MARKET.

Description: leaf-stalk below the lower pair of leaflets short and thick; ridges eight to ten with shallow furrows between them, only the central ones well defined in a cross section. Fibro-vascular bundles about thirteen, nine of which are large and embedded in green cells. There is a constriction at the joint from which the lower pair of leaflets grow, and the tissue is lighter colored at this point than elsewhere. Above the joint the main stalk is stout but tapers rapidly to the end. Leaflets thick, very green, glossy on both sides when young, and supported by short, rigid branches of the stalk. Lobes rather deeply cleft, serrations shallow, each tooth terminating in a whitish point. Plants with numerous secondary crowns, fibrous roots, and succulent stalks and leaves which are green of the deepest dye.

Specimens of this variety were exhibited by Ichabod Washburn at the fall exhibition of the Worcester County Horticultural Society in 1853.[1] Mr. C. N. Brackett, who was chairman of the committee on vegetables of the Massachusetts Horticultural Society in 1869, writes in that year in Tilden's Journal of Horticulture,[2] as follows: "This is considered one of the finest varieties of this highly esteemed vegetable when grown either for family use or for more extensive culture for market." This celery retained its popularity among growers, particularly in the vicinity of Boston, until the self-blanching kinds appeared, and even now large fields of it are cultivated. It is perhaps unsurpassed in quality by any other variety, and its short growth and late maturity make it a desirable kind for winter use, but in the race for the almighty dollar it is gradually being left behind.

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[1] Trans. Worcester County Hort. Soc. 1853, p. 79.

[2] Vol. V, No. 5, p. 277.

FIG. 8. Boston Market Celery. The oldest variety of celery that is now extensively cultivated in New England.

Plant about 18 inches high.

GOLDEN OR GOLDEN HEART.

Description: leaf-stalks below the lower pair of leaflets six to nine inches long and from two and a half to three inches in circumference, green, with nine distinct bundles. Furrow in front side of stalk five-eighths of an inch wide. There is no constriction where first pair of leaflets form. The leafy portion above the first joint about twice as long as the stalk below. Leaflets large, thick and supported by fleshy branches of the stalk. When light is excluded from the plants the younger leaves change to a bright yellow color. Plants rather large, leafy and spreading, slightly turnip-rooted.

The zenith of the popularity of this type of celery seems to have been reached about ten or twelve years ago. In 1886 it was the leading kind around New York and in the great celery-growing district of Kalamazoo, Michigan.[1]

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[1] Gardening for Profit, Third Edition, p. 185.

FIG. 9. Golden or Golden Heart. The most popular variety of celery about New York and in Kalamazoo, Mich., before the self-blanching kinds were introduced.

Plant 2 feet 3 inches high.

WHITE PLUME.

Description: leaf-stalk below the lower pair of leaflets eight to ten inches long, one to two inches in circumference, light green, ridges on back of stalk nine, with thirteen fibro-vascular bundles. Furrow in front side of stalks three-eighths of an inch wide. Portion of leaf above the first joint a foot or more long. Leaflets rather large, turning light colored or sometimes nearly white as the plants approach maturity. Plants spreading, rather leafy, not a "full hearted" variety. Considerably turnip-rooted and with few secondary crowns.

It was introduced by Peter Henderson in 1884, and concerning it he wrote as follows:[1] "It originated in what is known as a sport from the Half Dwarf; that is, a single plant showed the whiteness of stem and peculiar feathery leaves, which, fortunately, permanently reproduced itself from seed and gave us this entirely new type of celery." Only four years later, in 1888, Mr. Henderson stated[2] "that the sale of this kind of celery seed amounted to nearly a thousand pounds annually." It is the most decorative of all celeries, but it is often of strong flavor, and while this may be due largely to improper attention to the ripening process, nevertheless its deceptive appearance has injured its reputation in the New England markets and for the last few years it has gradually fallen into disfavor, although it is still quite generally grown. In vigor of growth it is more thrifty than the variety which is being used in its place, viz.: the Paris Golden.

[1] Garden and Farm Topics, p. 167.

[2] Gardening for Pleasure, (Second Edition), p. 324.

FIG. 10. White Plume. The first American self-blanching celery. Introduced by Peter Henderson & Co., in 1884.

Plant 2 feet high.

ROSE.

Description: leaf-stalks below the lower pair of leaflets ten to twelve inches long, one and a half to two inches in circumference, ridges nine, and the furrows between them rather shallow. Fibro-vascular bundles thirteen. Plants tall, leaflets inclined to turn inwards, stalks with more or less crimson color, particularly near the base. When the stalks are blanched, the red upon them appears brighter in contrast with the white, a quality which gives variety to this vegetable when served upon the table.

This particular type was introduced to American gardeners in 1886,[1] and perhaps it is the most popular form of the red varieties at the present time. We do not find so much improvement among the red as among the white varieties. They have always had their patrons since celery culture began in America, and not infrequently growers have been advised to increase their plantations of them, but still they desist, and this is presumably because the red varieties that have appeared in the trade have been inferior for general market purposes to the white varieties with which they came in competition.

[1] Gardening for Pleasure, (Second Edition), p. 324.

FIG. 11. Rose Celery. Perhaps the best of red varieties, of the old type.
Plant 2 feet 6 inches high.

PARIS GOLDEN OR GOLDEN SELF BLANCHING.

Description: leaf-stalks below the lower pair of leaflets very short, six to eight inches, and from one and a quarter to one and three-quarter inches in circumference, generally with nine distinct ridges and thirteen fibro-vascular bundles. The bundles are not surrounded by green cells when the plants are mature and they are only slightly conspicuous in a cross section. The ridges are flattened and the furrows between them shallow. Leaf-bearing portion of the stalk twelve to fifteen inches long, with a decided constriction where the first pair of leaflets unites with it. The lower pair of leaflets are large and turn backward and outward in a peculiar manner. Secondary crowns are not numerous and the plants are but slightly turnip-rooted. When scarcely more than half grown yellow specks begin to appear in the older leaves, and these gradually become more numerous until the whole plant assumes a yellowish hue. A few of the other newer kinds have similar yellow specks in the leaves, but thus far the Paris Golden celery is conspicuously distinct from all others. It is of short, stocky growth, can be planted closely, conveniently blanched with boards of ordinary width, packs in small space when blanched, is exceptionally attractive when exposed for sale in the markets and it never has the objectionable strong flavor that often accompanies the White Plume. No variety of celery at the present time seems to be so well adapted to garden culture as this, and no variety is as generally cultivated. Seeds sent to this Station by eleven representative seedsmen in different sections of the country produced plants noticeably true to the type. Eight lots were marked Golden Self Blanching, two Paris Golden Yellow, and one Paris Golden.

This variety was raised by M. Chemin in his market gardens near Paris.[1]

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[1] Vilmorin-Andrieux, The Vegetable Garden, Eng. Ed., p. 187.

FIG. 12. Paris Golden or Golden Self-Blanching. The leading variety of celery at the present time.

Plant 22 inches high.

GIANT PASCAL.

Description: leaf-stalk below the lower pair of leaflets very large, rather long, generally with about twelve flattened ridges and shallow furrows between them. Fibro-vascular threads about sixteen, not large, edges of the stalks much thickened. Internodes between the pairs of leaflets usually long excepting in cases where the first and second or the second and third pairs grow close together. Leaflets with conspicuous stalks and long blades deeply cleft and coarsely serrate. Plants with unusually large stalks and full centres, often without secondary crowns at base, and as far as we have observed not at all turnip-rooted.

The Giant Pascal is a variety peculiarly adapted to the production of a large amount of edible matter. The stalks are of the largest size, tender, and so far as our observations have extended, always of mild flavor even before they are blanched. The stalks are not, however, protected by a strong cuticle, consequently their surfaces are exposed to all kinds of accidents and in blanching they are often badly disfigured. Perhaps as a variety it represents the highest type of the garden celery at the present time, although it is probably not the best for market purposes.

FIG. 13. Giant Pascal. The illustration on the cover of this Bulletin was made from specimens of this variety of celery taken from the Station garden, March 15.
Plant 2 feet 6 inches high.

BROAD RIBBED.

Description: leaf-stalk below the lower pair of leaflets short and stout, five to seven inches, about two or two and a half inches in circumference, with eleven distinct ridges and sixteen fibro-vascular bundles, furrow in front of stalk one-half inch wide. Portion of stalk above the first joint longer than the lower part, nine to eleven inches. Leaflets rather narrow and contracted in appearance, stemlets rigid. Plants fleshy throughout, without secondary crowns, root solid just below attachment of leaves, but only slightly enlarged. The leaves naturally diverge leaving a wide crater in the center of the plant before the blanching process begins. The foliage of individual specimens of this variety often turns yellow as the plants approach maturity in the same manner as those of the Paris Golden, although in a less degree. In fact it appears to be an intermediate form between the Giant Pascal and the Paris Golden, yet entirely distinct from either of them. It matures earlier than the Pascal but later than the Paris Golden. Some strains have considerable red upon the stalks while others have none.

The type appears to be of very recent introduction. It was received at this Station under the following names: "New Giant Red," "New Large Red Ribbed," "New Red Pascal," "English Walnut," "Kalamazoo Broad Ribbed," "New Broad Ribbed," and "Sweet Nut." As we find no account of the origin of this type in this country, we infer that it is an importation from Europe.

FIG. 14. Broad Ribbed. A new type of celery, the merits and demerits of which are as yet only imperfectly known.

Plant 20 inches high.

APPLE SHAPED CELERIAC.

Description: leaf-stalks below the lower pair of leaflets four to six inches long, one to one and a half inches in circumference, with seven to nine distinct ridges and eleven or thirteen fibro-vascular bundles. Upper portion of leaves rather broad and short. Plants low and spreading, stalks of light weight and often hollow; root much enlarged, three to five inches in diameter. As the plants approach maturity the growth takes place in the thickened root, which is the only part eaten. It is but little grown in this country except for those who have learned to use it elsewhere. It has the true celery flavor but lacks the delicacy and crispness peculiar to the more common kinds. It does not, however, require blanching and it can be as easily stored as the turnip. It is always served in a cooked condition and it is not to be despised even in the presence of a dish of fresh stalks of the Giant Pascal, although the latter is generally preferred when only one can be had. The Station collection contained celeriac seed under the following names: "Apple Shaped," "New Apple," "Giant Smooth Prague," and "Giant Turnip Rooted." There was a decided similarity between the varieties, although they were not identical. The Apple Shaped is a little less coarse than the older varieties. Although celeriac appeared among the earlier forms of cultivated celery it is evident that but little attention has been devoted to the developments of new varieties of it.

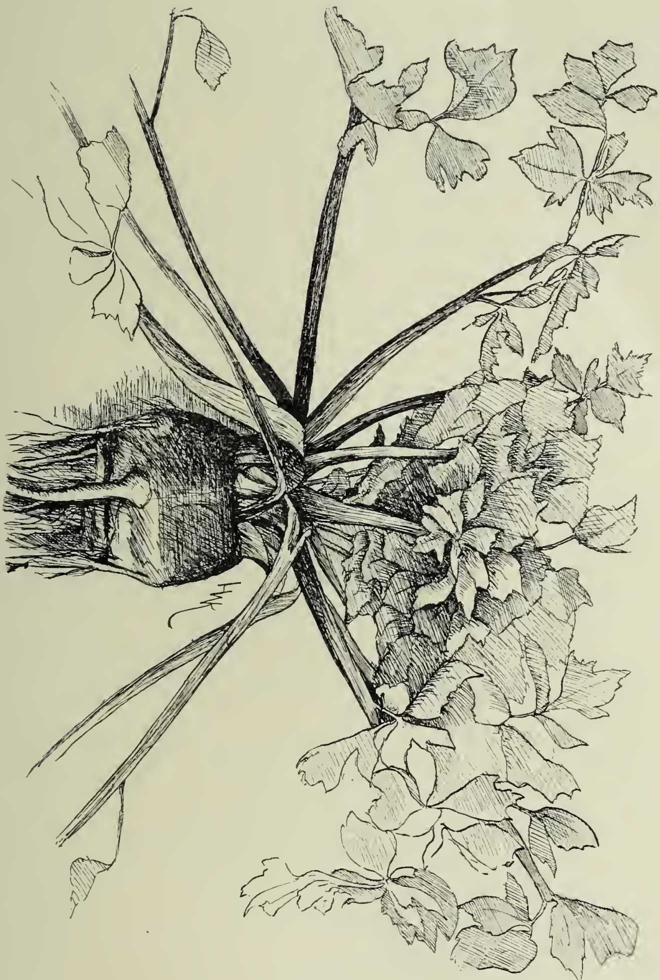

FIG. 15. Apple-Shaped Celeriac.
Plant 1 foot high.

Additional Varieties.

Besides the foregoing there was a lot of varieties with less important but distinctive characteristics. These may be grouped about those already described, for convenience, although the names are not to be regarded as synonyms, but rather as varieties having more or less resemblance to one another.

Boston Market..	Early Arlington. Dwarf Arlington.	
	Solid Ivory, Dwarf White,	Plants without secondary crowns and having light green foliage.
	Cooper's Cutting,	Leaves and stalks small and numerous.
Golden Heart . .	Crawford's Half Dwarf, Schumacher, Large White Solid, Giant White Solid, White Solid, Pearle Le Grand, Pearce's Alpha, Silver Giant White Solid, New White Half Dwarf, Selected Golden Heart, Self Blancher, White Walnut, Dilk's Many Hearted, Golden Dwarf, Golden Half Dwarf,	A miscellaneous group of varieties mostly destitute of striking characteristics.
Rose.	Pink Aromatic. Boquet. Crimson. Dwarf Crimson. Incomparable Dwarf Crimson. Convent Garden Rose. Dwarf Rose.	
White Plume . . .	Pink Plume.	

GIANT PASCAL...	Perfected Hartwell,	Although slightly resembling the Pascal in appearance it is entirely distinct. It has smaller stalks, less pointed leaves and the plants are more spreading in habit of growth.

BROAD RIBBED...	Large Red Ribbed. Kalamazoo Broad Ribbed. New Broad Ribbed. Sweet Nut. English Walnut. New Giant Red. New Red Pascal.

Two varieties of a distinct type, although of questionable value, were received under the names "Australian Golden Gem," and "New Italian Arezzo." The varieties were characterized by a coarse, leafy growth, deep green color and the absence of what are considered desirable garden qualities. They did, however, resist the attack of the "blight" better than any other varieties in the field.

AN HISTORICAL SKETCH OF CELERY CULTURE.

When the cultivation of celery began no one can state with certainty. It was surely long ago, perhaps even before the beginning of the Christian era, but it was fifteen centuries after this time before celery became a common garden vegetable, and as such it has been cultivated only three or four hundred years, while the cabbage, lettuce, onion and some other vegetables have been grown in kitchen gardens for as many thousand years. Celery is spoken of by Homer and Theophrastus under the name of *Selinon*, but later Dioscorides distinguished between the wild and cultivated celery.[1] It is probable, however, that the celery was first prized for its medicinal properties rather than as an article of food. Pliny the Elder, in writing of the "Pleasures of the Garden" some

[1] DeCandole, Origin of Cultivated Plants, p. 90.

eighteen hundred years ago, says that "it was a sign of a woman being a bad and a careless manager of her family, when the kitchen garden was negligently cultivated,"[1] and he mentions some of the vegetables that were grown, but celery is not included in the list. Dr. Sturtevant writes[2] that the first mention of the word celery that he has observed is in Walafridus Strabo's poem entitled "Hortulus," where he gives the medicinal uses of Apium, and in line 335 uses the word as follows:

"Passio tum celeri cedit devicta medelaē,"

and he writes that it may be liberally construed as "The disease then to celery yields, conquered by the remedy." Dr. Sturtevant states also that Strabo wrote in the ninth century, and that he cannot find any mention of *celery* in Fuchsius (1542), Tragus (1552), Matthiolus Commentaries (1558), Camerarius' Epitome (1558), Pinæus (1561), Pena and Lobel (1570), Gerarde (1597), Clusius rar. plant (1601), Dodonacius pempt. (1616), or in Bauhin's Pinax (1623). Parkinson's Paradisus (1629), mentions "sellery" as a rarity, and Ray in Historia plantarum (1686), says "the smallage transferred to culture becomes milder and less ungrateful, whence in Italy and France the leaves and stalks are esteemed as delicacies, when eaten with oil and pepper." Before seventeen hundred, however, we find the use of celery established in England. We need no better proof of this than John Evelyn's statement in "Acetaria," published in 1699, where he writes,[3] "sellery, *Apium Italicum*, was formerly a stranger with us, (nor very long since in Italy), is an hot and more generous sort of Macedonian Parsley or Smallage, . . . and for its high and grateful taste it is ever placed in the middle of the Grand Sallet at our great men's tables and Prætor's Feasts as the grace of the whole board." Exactly when celery began to be grown for market in this country is uncertain, but it may have been as early as the beginning of the present century, although if so it was grown only on a small scale for the first thirty or forty years. In 1806, McMahon[4] names four varieties. Celery was not exhibited at the horticultural exhibition held at Worcester in 1847, and at a similar exhibition the following

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[1] The Garden, (Howe), p. 33.

[2] E. Lewis Sturtevant, American Naturalist, Vol. XX, p. 602.

[3] P. 63.

[4] Am. Gardener's Kalendar.

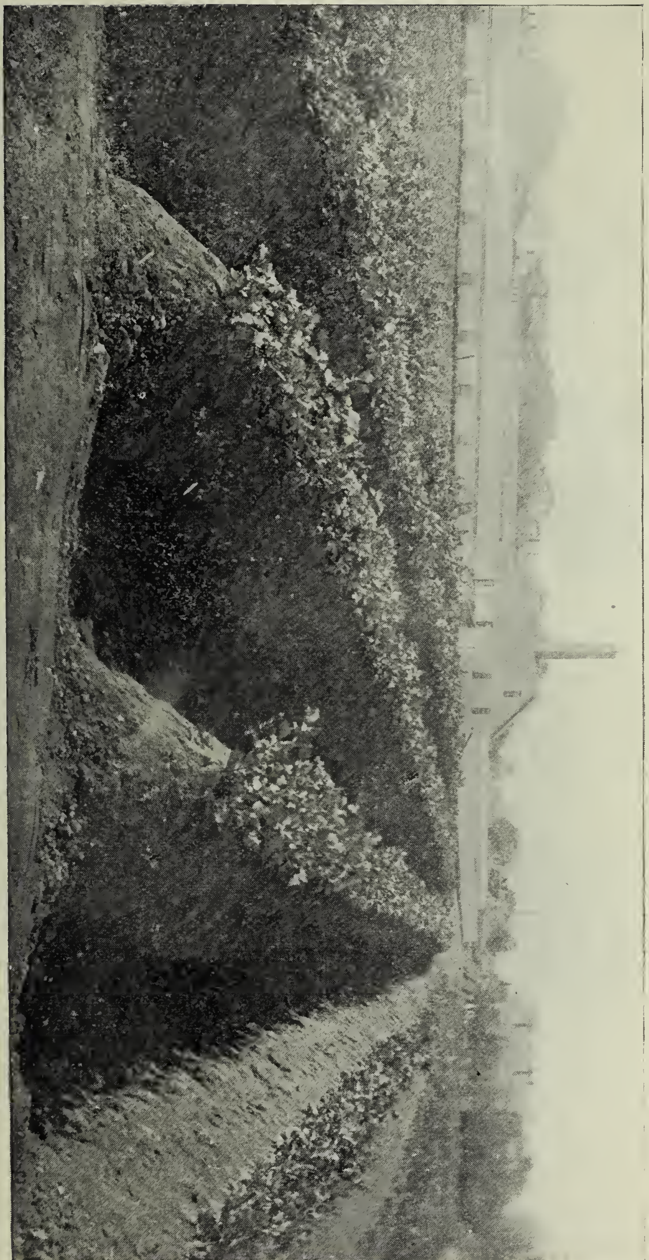

FIG. 16. Field of Giant Pascal Celery. Banks three feet high.

From a photograph taken October 22, 1896, in the market gardens of W. W. Rawson, Arlington, Mass.

year there was but a single exhibitor of this vegetable, and he entered it as celery, without designating the particular variety.[1] In 1851 a reader of the *New England Farmer*, then printed at Quincy Hall, requested the editor to quote the price of celery in the Boston market. He answered the request by stating that there was very little of that article sold in that market and that the prices were transient, varying every few days.[2] In 1853 distinct varieties of celery had begun to attract the attention of amateur horticulturists in the vicinity of Worcester, for in the autumn of that year Ichabod Washburn exhibited specimens of Seymour's Superb, Solid White and Boston Market, at the exhibition held in that city.[3] In 1856, *The Homestead*,[4] then published in Hartford, Conn., speaks of celery as "one of those vegetables which though rarely cultivated really merits a place in the smallest garden. The plants should be set in the bottom of trenches six to twelve inches deep, in double rows, the plants standing about six inches apart in the row." The writer also stated that the soil in the bottom of the trenches could not easily be made too rich with well rotted stable manure for celery, an assertion that has been well supported by the experience of gardeners during the forty years which have elapsed since that time. Celery culture seems to have first developed into an industry in the vicinity of New York city, where Peter Henderson wrote,[5] in 1858, that he raised thirteen or fourteen acres, each acre containing 30,000 plants; and furthermore, that he was by no means the largest grower of that vegetable, there being several others who grew nearly double that quantity. Mr. Henderson had at this time abandoned the custom of settling celery plants in trenches, believing that by this method unnecessary inconvenience was involved, and he pointed out in his numerous communications to agricultural papers the absurdity of the old practice and the advantages of the new. Probably the rapid development, after this time, of celery culture throughout this country was due more to the efforts of Mr. Henderson than those of any other man. He was actively engaged in the cultivation of this vegetable on a large scale, and being a prolific writer

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[1] Trans. Worcester County Horticultural Soc., 1848, p. 33.

[2] New England Farmer, Vol. III, p. 90.

[3] Trans. Worcester County Horticultural Soc., 1853, p. 79.

[4] Vol. I, p. 691.

[5] Country Gentleman, Vol. XI, p. 126.

he gave his countrymen the benefit of his experience. Many of them have been taught by him how to grow this crop, and an appetite for celery seems to be a common inheritance of the American people.

It was about 1860 when the first booklet on American celery culture was written by M. Rœssle, the landlord of the Delavan House, at Albany, of whom Mr. Alexander Hyde writes,[1] in 1869, as follows: "whoever has enjoyed the hospitality of this favorite hotel under M. Rœssle's care, and had his eyes delighted, his palate tickled, and his whole body refreshed, with the beautiful and delicious white and pink celery always found there in the greatest abundance, must have been convinced that the landlord not only knew how to keep a hotel, but what is more, to keep a good garden." Mr. Hyde writes further that he practiced Mr. Rœssle's mode for several years and had good success; but he always felt when digging the trenches, filling in the surface soil and manure and turnpiking the bottom of the trenches, so that in case of rain, the plants might not be drowned,—that there was too much labor for those who make a living from their gardens or for those who raise their vegetables by the sweat of their own brows; but, he adds, thanks to Peter Henderson, we now practice a simpler and easier mode.

The Boston Market was the variety preferred by Mr. Hyde. Seymour's Superb, he writes, has a more superb look, but requires much more space and labor in its cultivation, and when grown it is less tender and delicate. Mr. C. N. Brackett writes,[2] also in 1869, concerning the Boston Market celery, as follows: "It is recommended as one of the best sorts in cultivation, either for the kitchen garden or for more extensive culture. It is the established favorite with the celery growers in this vicinity, where large quantities are grown to supply the Boston market."

At this time or only a few years before, the celery crop in Rhode Island "was not worth mentioning," and in 1875 it only amounted to $1,800.[3] Between 1875 and 1885, Rhode Island gardeners learned how to grow celery on a large scale. "Decided improvement has been made within a few years in market gardening,—especially in raising celery," writes Mr. Amos Perry in the edition

[1] Tilden's Journal of Horticulture and Floral Magazine, Vol. VI, p. 205.

[2] Tilden's Journal of Horticulture and Floral Magazine, Vol. V, p. 276.

[3] R. I. Census, 1885, p. 566.

of the census already referred to: "Honor to the men who cultivate and bring within our reach the good things of this earth, ... all classes of our citizens have a direct interest in this branch of industry." In 1885 the output of celery from Rhode Island gardens was valued, not at $1,800, as was the case ten years before, but at $25,081,[1] and since that time the progress in the cultivation of this vegetable has not abated. Doubtless there are many gardeners in this as well as in other States who work hard in their celery fields and get but small wages for their services, yet this is not necessarily a fault of the crop. The same individuals if they should attempt to conduct some other enterprise might fare

FIG. 17. Field of Boston Market Celery. Banks one foot high.
Grown by W. W. Rawson, at Arlington, Mass. Photographed October 22, 1896.

even worse, and not get any wages at all. Until about ten years ago celery was considered a winter vegetable, the main part of the crop being stored away from frost upon the approach of cold weather, but more recently a summer and fall demand has developed so that now two crops of celery are occasionally taken from a single field in one season. Last summer celery from local gardens

[1] R. I. Census, 1885, p. 515.

began to appear in the Providence markets before the fourth of July, and the main part of the crop was sold before the holidays. Thus only a comparatively small proportion of it passed through the uncertain and annoying storage process. Formerly the summer celery was mainly raised in cool bogs in Michigan and shipped into the eastern markets, but now after repeated trials it has been shown that it can be grown here on ordinary garden soil if the crop is properly managed. Furthermore, it is believed that the cultivation of this crop is even less precarious than the storing of the late fall crop; yet it is to be hoped that an improved method of keeping celery will be discovered which will enable growers to supply this vegetable throughout the winter at a moderate price,

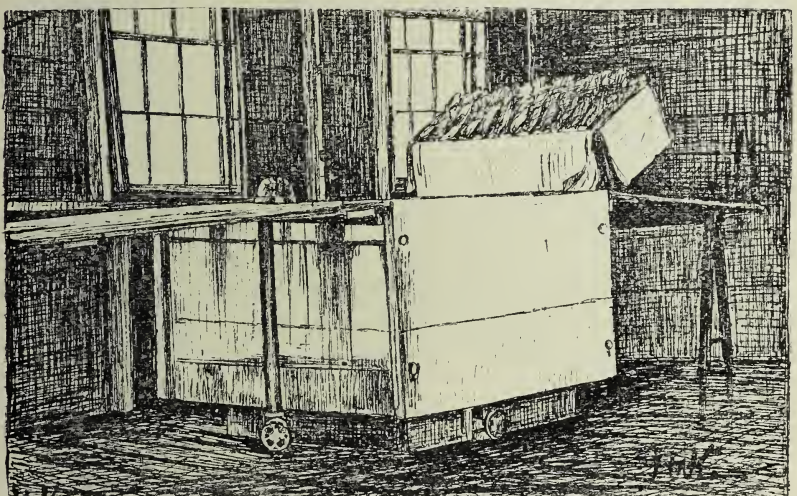


FIG. 18. Washing Box used by C. W. Patt & Son, market gardeners, of Auburn, R. I. Besides sundry other vegetables, about 4,000 dozen bunches of celery have passed through this box on their way to market during the past season.

and still leave a margin of profit for their enterprise. A demand for celery during the winter months is assured, but the present methods of keeping it are defective for commercial purposes in being either too wasteful or requiring too much labor. Observation and experience leads us to believe that the best winter celery is that which is protected by covering it with earth and forest leaves in the field where it is grown, without disturbing the roots

until it is wanted for use. A more common method is to lift the plants and store them in temporary buildings or cover them in trenches. The principal difficulty experienced when celery is placed in structures above the surface of the ground is to keep the temperature uniformly low without freezing the plants, and when buried with earth to perform the necessary work involved in getting the plants into trenches and out again without having it cost as much as the celery will bring when bunched and in the market. So far as we have been able to learn there has been little progress in the art of keeping celery during the last forty years. In 1858 Peter Henderson described[1] his method of keeping celery in trenches, and stated that by that system he managed to keep up a supply for the New York market of about fifteen thousand roots per week from December to April with a loss of scarcely five per cent. The details of the operation have been frequently described and illustrated since that time, and it is still perhaps the most reliable method practiced, being subject, of course, to such minor modifications as local conditions may require. Mr. Henderson pointed out the importance of having the trenches narrow, of delaying the lifting of the plants until the ground became thoroughly cold, and of covering the trenches lightly with leaves at first and increasing their depth when necessary to prevent the frost from reaching the plants; and furthermore, he demonstrated in a most emphatic and practical manner that celery could be kept in good condition in this way from the time the ground froze up at the beginning of winter until it thawed out in the spring, but it still remains for somebody to discover how celery can be kept equally well with decidedly less expense.

THE NEW CELERY CULTURE.

A discussion of the cultivation of celery in Rhode Island would be incomplete without a reference to this method of growing celery, which became somewhat popular several years ago, and which is still successfully practiced, mainly as the result of the experience and writings of a Rhode Island grower, Mr. Robert Niven, of Arlington. The essential difference between the new celery culture and the old or ordinary culture, lies in the fact that three or more times as many plants are grown to the acre by the

[1] Country Gentleman, Vol. XI, p. 9.

former as by the latter method. That is, the new celery culture anticipates intensive cultivation of the highest order, and with this it has been proven that enormous crops of celery of good quality can be grown from small areas. Last September the *Country Gentleman* published a communication from W. H. Jenkins, of Delaware Co., N. Y., in which he wrote in part as follows: "I have been experimenting for several years with what is called the new celery culture; that is, growing celery in rows from six inches to a foot apart. . . . . To-day I expressed a basket of celery to

FIG. 19. The celebrated field of Paris Golden Celery, grown by the "New Celery Culture," in Providence, R. I., in 1891, by Robert Niven.[1]
The plants were seven inches apart each way.
Photograph furnished by Mr. Niven.

a fashionable hotel. It was fine celery, and I obtained a fancy price for it. As I wished to know how much the land on which I grew it was paying me per acre, I measured the space from which the celery was taken and found that I was getting over $30 per square rod."[2]

Celery was grown in beds as early as the middle of the present century, and it is probably an adopted English custom that has been modified from time to time. In 1852, a Mr. Cox, in a discus-

[1] Described in *Rural New-Yorker*, Vol. 51, p. 181.
[2] Vol. 61, p. 684.

sion before the Cincinnati Horticultural Society,[1] spoke of the bed method as being more economical than either single or double rows because less earth had to be moved in blanching. He said, "When this plan is adopted the rows runs across the bed, which may be three or four feet wide." He also spoke of setting up boards which were clasped at the top to hold the leaves together so that earth could be thrown in between the plants without injuring them. The beds at that time were, presumably, in wide ditches. Eight years later this plan was described[2] as growing celery according to a "new theory," and in 1862, thirty-five years ago, celery plants were set in beds upon the surface. A New Jersey market gardener wrote to the *Gardener's Monthly* at that time, that growing celery in this way was "as easy as raising a crop of cabbages,"[3] but the experience of gardeners since then has shown this statement to be somewhat overdrawn, if it was ever intended to be literally true. The advantages of this method became more apparent after the so-called Self-Blanching varieties of celery began to be grown, and it has gained in public favor during the last ten years, although comparatively few gardeners are prepared to give the "high culture" which the method demands, and in consequence it frequently proves unsatisfactory. That it admits of a larger yield there is no doubt, but it is equally true that it involves a relatively larger expense; therefore circumstances alone can determine whether the new culture is preferable to the ordinary culture or not. Being able to make two celery plants grow where only one grew before marks no special progress in the art of cultivating this vegetable, unless the cost of production per plant is thereby reduced or the quality of the product improved. We think, however, that the bed-method of growing celery for market has much to recommend it where the beds can be adequately and economically watered. Perhaps the strongest argument in favor of the method is that when the plants are set from eight to twelve inches apart each way the leaves soon shade the ground completely and thus protect the roots from the burning rays of the sun, but plants grown in this way must be fed and watered with as much care as those crowded together on a greenhouse bench. Neglect even for a few hours may cause irreparable

[1]Journal of Agriculture, Vol. II, p. 368.

[2]Country Gentleman (1860), Vol. XIV, p. 271.

[3]American Agriculturist (1862), Vol. XXI, p. 76.

damage to the crop. Plants that are grown in beds can be blanched with boards, or if wanted for winter use they can be banked with earth until covered well out of sight, then protected from frost by a thick layer of leaves or other coarse material.

When the plants are to be covered in the field where they have grown it is probably better to set them in trenches than upon the surface. The earth taken from the trenches can then be used in banking the plants, and they are not as likely to freeze if below as if above the natural surface of the land.

SUMMARY.

1. Celery is one of the choicest products of the vegetable garden and one for which no substitute is known.

2. As a branch of industry celery culture has prospered in Rhode Island for fifteen years or more, and celery may have been grown here for market as early as the middle of the present century.

3. No cooking or other process has yet been discovered by which the blanched and tender stalks of celery can be made more palatable then when they leave the gardener's hands—if he has done his work well; consequently the grower and consumer are brought nearer together in this case than when the products take a more circuitous route and pass through mills, canning factories or the like. In other words, the grower of celery performs the skilled labor which gives it its principal value, instead of furnishing a coarse product to be refined by other classes of workmen.

4. Black-heart and celery blight as known among Rhode Island growers seem to be indicators which appear upon the leaves of celery plants to show when their roots are abused. The application of a mulch over the roots is a more effectual remedy than the use of lotions upon the leaves.

5. Fortunately none of the old settlers among Rhode Island insects have yet acquired a morbid appetite for celery, and so far as we are aware none of the transient population of this class have caused any serious trouble in the local celery fields.

6. Sub-irrigation through two-inch drain tiles laid in lines ten feet apart and eighteen inches below the surface was less satis-

factory than surface irrigation, in the Experiment Station celery field.

7. Fresh sea-weed when placed in the irrigation ditches between the rows of celery prevented the soil from washing and also absorbed a large amount of water, which was released gradually as the soil about it became dry. It also proved an excellent mulch when spread two inches thick about the plants.

8. Probably new varieties of celery have been added to American seedsmen's lists at the rate of more than one a year for the last fifty years. Evidently their lists were not long at the middle of the present century. We know that many varieties have come and gone since then, still we found fifty-nine offered for sale in the United States and Canada last spring (1896).

9. The varieties that have been recognized by growers as having special merit are Seymour's Superb, Sandringham (Incomparable Dwarf), Boston Market, Golden and Golden Heart, White Plume, Rose, Paris Golden and Giant Pascal. The Broad Ribbed is a new type which growers generally know but little about, and Celeriac is not extensively grown for market in Rhode Island.

10. The Paris Golden or Golden Self-Blanching celery is distinct from all other varieties, and probably more of this than of all other kinds is grown in the local market gardens.

11. Market-men prefer Paris Golden celery because it never has the strong, bitter flavor sometimes present in White Plume, not properly blanched; although on account of its self-blanching tendencies it is frequently marketed before the stalks are properly ripened.

12. When White Plume and Paris Golden plants are growing side by side in the same field, the latter are sometimes seriously damaged by the black-heart when the former escape.

13. It is claimed that the Giant Pascal celery is, like the Marshall strawberry, too good for ordinary market purposes.

14. Peter Henderson was one of the pioneer celery growers about New York, and as early as 1858 he planned to market about fifteen thousand heads per week from December to April.

15. The first American booklet on celery culture appears to

have been written by M. Rœssle, landlord of the Delavan Hotel at Albany, N. Y., of whom it was said that he not only knew how to keep a hotel, but what was more he knew how to keep a good garden.

16. It was Peter Henderson who advocated the change from the trench to the surface method of growing celery between 1850 and 1860, and the development of celery culture as a branch of industry seems to have been due more to his writings than to those of any other one person.

17. After celery culture was simplified by abandoning the trenches, it was twenty-five or thirty years before another equally important advance was made, which appeared between 1885 and 1890, in the use of boards instead of earth for blanching celery. This practice followed the introduction of the self-blanching varieties.

18. The White Plume is an American seedling and was introduced by Peter Henderson & Co. in 1884. For a few years it was exceedingly popular among growers and it is still grown in many market gardens in Rhode Island.

19. The Paris Golden originated in the garden of M. Chemin, near Paris, France, probably at about the same time that the White Plume originated on this side of the Atlantic.

20. The Giant Pascal and Broad Ribbed also appear to be of European origin.

21. The Boston Market celery, although but little grown in Rhode Island, is still found in the market gardens about Boston, where it has been grown for more than forty years. The variety has changed during this period, but it is still "Boston Market."

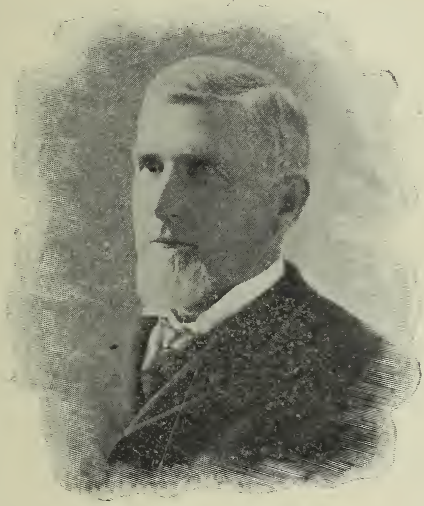
22. By the "new culture" celery plants are set from eight to twelve inches apart each way in beds, and when skilfully managed very large yields are secured, but when the beds are neglected often proportionately large losses are sustained.

Bulletin 45. April, 1897.

KINGSTON, RHODE ISLAND.

THE LOGANBERRY

FROM SEED TO FRUITAGE.



JUDGE J. H. LOGAN.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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*The duties of the former Poultry Manager have been assigned to the Agriculturist.
† Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 45.

THE LOGANBERRY.

L. F. KINNEY.

If we recall the newer types of small fruits that have been gradually introduced into gardens during the last ten years, we find among them the Crandall currant, the Dwarf Juneberry, the Japan wineberry, the Japan Mayberry, the Strawberry raspberry and the Loganberry. The Crandall currant is a modified form of a bush that was formerly grown only for ornament; viz. the Flowering or Missouri currant. The fruit is like that of the Flowering currant in both flavor and appearance, but it is considerably larger and the bushes are much more prolific. There is no doubt but what this is a valuable type of fruit, although I am not aware that it has found any place in the markets.

The Dwarf Juneberries are varieties of the Shadbush, *Amalanchier Canadensis*, which have been transferred from thickets to nurseries and propagated. The fruit is like that of the wild bush which is a very common shrub in Rhode Island, blossoming freely every spring but fruiting sparingly. In their present form the Juneberries have no commercial value in this locality.

The Japan wineberry,[1] as its name indicates, comes to us from Japan and is a species of the raspberry, in which the hull or calyx encloses the berry in the earlier stages of its growth, but which opens out about the time that the berry begins to color, leaving it fully exposed when ripe. The berries are vivid scarlet, but according to our tests not highly flavored. The canes have winter-killed badly at the Experiment Station, even when efforts have been made to protect them. To us the wineberry seems but an inferior kind of raspberry about which enough is already known to justify the statement that there is no place for it in the commercial fruit gardens of Rhode Island.

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[1] *Rubus phœnicolasius.*

Two years ago we set out six nice plants of the Mayberry, but with the best care that we could give them we have not seen a fruit or even a blossom yet. Three of the six plants died outright during the first winter, and this when they were carefully covered with earth. The others made only a feeble growth last season and were scarcely more than eighteen inches high when covered last fall. Evidently this plant has too delicate a constitution to thrive here—a fault in itself sufficient to render it ineligible for field cultivation.

The so-called Strawberry raspberry[1] has been grown in the Experiment Station garden for two years, and it appears to us to

Fig. 1. The Loganberry, (one-half natural size).

be a veritable weed entirely destitute of desirable qualities for market purposes. We may, however, with longer acquaintance discover qualities which have not yet developed or that our plants do not represent the best type of this fruit. But little has yet been published concerning it except by parties interested in

[1] *Rubus sorbifolius.*

the sale of plants, consequently we have been able to compare our notes with those of only a few others who have fruited it. The fruit produced by the plants here was ugly in appearance, insipid in flavor and there was but little of it, while the plants spread more rapidly than quack grass.[1]

The subject of this bulletin, the Loganberry, differs from all of the fruits that have been mentioned in that it possesses qualities of interest to those who grow berries for market. It is not only conspicuously distinct from every other fruit, but the berries are as large as the largest small fruits, attractive in appearance, of fair quality, and the plants are strong growers and actually bear fruit enough to be of some value. Experience only can determine, however, whether the Loganberry can be grown here with profit.

The first important public notice that we have seen of this berry is a communication from Charles Howard Shinn, of Niles, Cal., which appeared, accompanied by an excellent illustration of a plant in fruit, in *Garden and Forest*,[2] in November, 1894. This description of the Loganberry, in which it was portrayed as an intermediate form between the raspberry and blackberry, partaking of the color and flavor of the former and the size and shape of the latter, immediately aroused the curiosity of such small fruit growers in the East as happened to see the article; but we are not aware that Loganberry plants were publicly advertised for sale in the Eastern States until the spring of 1895, although a limited number had been sent East prior to that time. The University of California propagated and disseminated Loganberry plants early in the nineties, before this work was undertaken by nurserymen, and in the Annual Report of the Experiment Station for 1894,[3] Prof. Wickson described and illustrated it, stating that "no single fruit excited more interest among visitors to the Station grounds than the Loganberry."

Although Loganberry plants have been obtainable for two seasons, comparatively few persons have yet seen the berries and the trade in the plants is just beginning in the Eastern States; therefore we trust that this bulletin will prove timely and of value, as well as of interest to those cultivating small fruits. The Logan-

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1 There is little resemblance between the berries produced by the plants at this Station and the illustration of this fruit which appeared in *Rural New-Yorker*, April 17, 1897, after the above was written.

2 Vol. 7, p. 466.

3 Page 340.

berry has been under observation at this Station two years, and the matter in the following pages is largely the result of our study of it here; still we have not confined our inquiry to the Station garden but have endeavored to collect for consideration all the available information concerning this interesting fruit. We besought Judge Logan for facts about its origin, and the communication which he kindly sent us is inserted, together with a reproduction of a photograph of Loganberries grown in the open air during the winter months in Santa Cruz, Cal. Those who have seen the Loganberries at this Station will recognize in this illustration an exact and not an exaggerated representation of them. With the exception of this cut and the portrait of Judge Logan upon the cover, all of the illustrations are from sketches of specimens in the Station garden.

WILL THE LOGANBERRY PROVE PERFECTLY HARDY HERE?

Probably not; none of the briar class of fruits have, even the canes of the wild raspberries and blackberries often winter-kill and we have never seen an imported variety the canes of which did not; still some of them are less likely to be seriously injured during the winter than others and growers regard this as an important quality. It is yet too soon to attempt to state exactly where the Loganberry should be placed in the scale of hardiness. It originated in an exceedingly mild climate where the temperature rarely falls below the freezing point[1] and where the fogs from the Pacific roll in, perhaps as frequently as those from the Atlantic do into the gardens along the coast here in Rhode Island. Yet it is the offspring of domesticated plants which happened to be brought together there. Whether these particular plants were to the manor born or not we do not know, still it is probable that they were sufficiently hardy in constitution to battle with the elements, if necessary, in other regions; therefore it is hoped that the field of usefulness of the Loganberry will extend much farther than the favored locality in which it by chance came into existence.

The Cuthbert raspberry had migrated by the aid of human agencies to Southern California and become "the ruling red raspberry" in the Santa Ana Valley fifteen years ago. Although this

[1] E. J. Wickson, California Fruits, p. 12.

is one of the hardiest varieties of this fruit in New England, Mr. D. Edson Smith, of Santa Ana, in an address before the California State Fruit Growers' Association in 1890, stated that "in some parts of that section of the country the Cuthbert was the most profitable raspberry to be grown and in other localities it seemed to winter-kill or live only at a poor, dying rate."[1] Thus it appears that the equable temperature of the coast climate of California is somewhat trying to this class of berries. We can grow the old Antwerp type of red raspberry by covering the canes in winter and this is supposed to be one of the races from which the Loganberry sprung, and the habitat of the other race, the native blackberry of California, extends over a region the climate of some parts of which approaches in severity that of New England. Concerning the hardiness and other merits of this wild blackberry, in Humboldt, one of the northern coast counties of California, A. P. Campton writes as follows: "I believe that there can nowhere be found a locality that can excel the Eel River Valley in the production of this wild berry. It grows and bears abundantly from the shores of the Pacific Ocean to an altitude of 2000 feet above the sea. For canning, preserves and as a dessert dish, the wild blackberry of Humboldt county stands at the head of the fruits, both wild and cultivated. It has that peculiar tart flavor that can be found in no other fruit, and which renders it so invaluable as a dessert dish." The blackberry grows long and spreading, the vines from it often exceeding fifteen or twenty feet in one year. The fruit is jet black when ripe, about half an inch in diameter, and from half an inch to an inch and a quarter long, growing in clusters of from three to seven, attached to prickly peduncles by slender, prickly pedicels. It is very prolific and ripens from the middle of June to the end of July.[2] The wild blackberry of California has been planted to some extent in the West and several varieties of it have been secured by selection and cutivation. The most famous of these is the Aughinbaugh, which was propagated and sold by a man of that name, about 1875. The blossoms of this variety are pistillate, consequently it had to be planted with other kinds, and for this and other reasons it became unpopular and has now nearly disappeared from the gardens of California.[3]

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[1] Report State Board of Horticulture of the State of California (1890), p. 156.

[2] Report State Board of Horticulture of the State of California (1890), p. 344.

[3] E. J. Wickson, California Fruits, page 54.

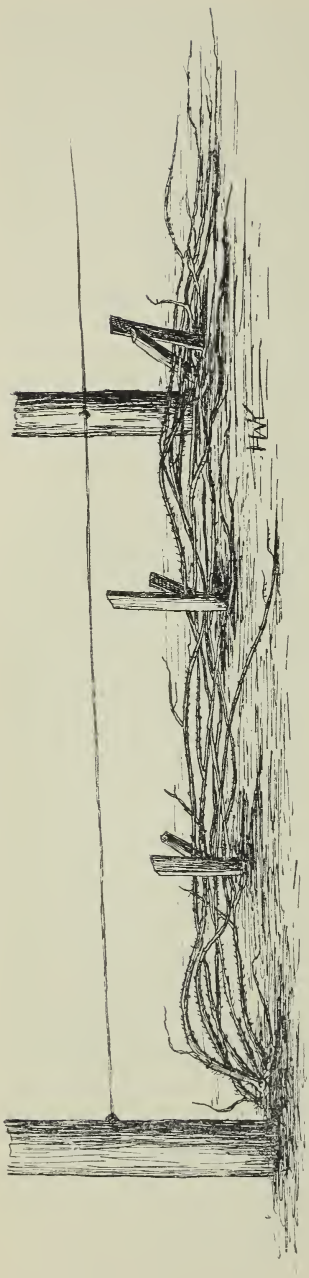

Fig. 2. Loganberry plant in position for covering with earth.

In plant the Loganberry is like this Aughinbaugh, of which it is a seedling, but we know less about the hardiness of this blackberry from actual experience than of the Loganberry itself, although we have a few plants of it growing at the Experiment Station. The winter of 1895 and '96 was so severe that it spoiled the crop of raspberries and blackberries that should have matured in Rhode Island last season, as well as about all of the blossom buds of the peach in New England; yet Loganberry canes that were covered with earth were not injured in the least. Some of them were ten feet long and alive clear to the tips when the earth was removed in the spring. None of the plants were left without covering that winter because the canes had grown late in the season and were so green and soft when the cold weather caught them that it did not seem possible they could survive the winter without protection. Last year, 1896, the Loganberry canes ripened earlier and by the 20th of November most of the leaves had fallen. Again the canes were mainly covered with earth, a few only being left untouched. The winter was less severe than the preceding, yet it was too much for the bare canes and most of them are dead nearly to the ground, and some of them are sixteen feet long. Those that were covered, however, are in admirable condition as before. We learned to cover rasp-

berry canes when it was a necessity in order to grow the choicest kinds of this fruit in New England, and have practiced it even since the introduction of the more hardy native varieties because it insures regular crops. But we have generally labored in vain when we have attempted to persuade growers that it is better to use the soil between the rows for this purpose than to allow it to lie idle during the winter when their raspberry canes are freezing to death. On account of the semi trailing habit of the Loganberry and the flexible texture of the canes, the covering process requires but little skill, and it seems to us a very simple operation; still it must add a trifle to the cost of producing the fruit.

SUPPORTS FOR CANES.

Another item to be considered by growers is that Loganberry canes naturally trail upon the ground, and consequently some provision must be made for keeping the fruit clean, which will add a little more to the expense of growing it. At the Experiment Sta-

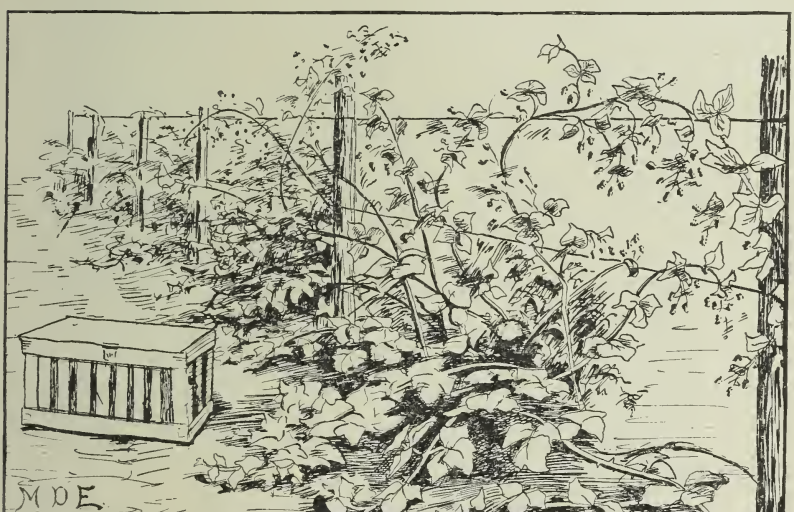

Fig. 3. Loganberry plants with the fruiting canes supported on wire trellis.

tion, a trellis made from cedar posts and No. 14 galvanized iron wire was provided, and when the plants were uncovered in the spring the canes were wound about the wires closely, in the same

way that we deal with raspberry canes. As the canes die after the fruit has matured they are easily stripped from the wires in the fall when necessary to make room for the new growth. Mr. James Waters writes me from Watsonville, Cal., that in his plantations of the Loganberry, which amount to about eight acres, he allows the canes to liê upon the ground, but he states there is very little rain when the fruit is maturing. It is not likely that this practice would prove satisfactory here where pelting showers are not uncommon during the summer months, although when the ground is mulched supports may not be necessary.

The Loganberry ripened here with the raspberries, still it was perhaps a little later and lasted somewhat longer. The berries were not highly flavored when eaten from the bushes but were much improved by cooking. As a sauce fruit it perhaps excels both the blackberry and the raspberry, being of richer color than the former and of milder flavor than the latter.

Fortunately the origin of the Loganberry is shrouded by no veil of mystery. The originator, Judge J. H. Logan of Santa Cruz, Cal., has recently retired from the Superior Bench, and is "one of those public spirited men who make the welfare of the community in which they live a matter of constant thought and action."[1] He has sought no pecuniary reward for his production but rejoices in having been able to make a contribution of recognized value to both scientific and practical horticulture. Mr. James Waters of Watsonville, Cal., the introducer of the Loganberry, writes me that it was "given" to him by Judge Logan, and a writer in *Beautiful Santa Cruz County* states that "while nurserymen have made enormous sales of Loganberry plants, the original owner, Judge Logan, has probably never made one cent or reaped any reward from it except the honor of giving it his name."[2]

Whatever the success of the Loganberry as a market fruit may be, its origin is sure to remain a matter of more than ordinary interest to the student of horticulture, and we are fortunate in being able to insert here information relating to this from the most reliable source.

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[1] Beautiful Santa Cruz County, p. 173.

[2] Page 53.

Fig. 4. Loganberry blossoms and berries (natural size); grown in the open air in Santa Cruz, Cal. Gathered and photographed January 8, 1897.

HISTORY OF THE ORIGINAL LOGANBERRY BUSH.

[A Communication from Judge Logan].

Your letter of inquiry in relation to the Loganberry is at hand, and in answer thereto I will say that prior to 1880, taking great interest in small fruits, particularly the blackberry and raspberry, I had tried in my garden every variety of those berries that I could obtain. Among them were the Texas Early, a high-bush, *Rubus villosus*, the Aughinbaugh, a pistillate dew-berry, and an old variety of red raspberry which had been cultivated here for many years, name unknown but resembling the Red Antwerp.[1] The Texas Early is sometimes called Crandall's Early, because brought to this State by Dr. Crandall of Auburn. I was not satisfied with any of these fruits as a table berry. The wild *Rubus ursinus*, of which the Aughinbaugh was the best variety obtainable, bore a fruit that was all that could be desired in flavor, but all of the *Rubus ursinus* type are weak growers and poor bearers, so much so that they are unprofitable for general cultivation. The Aughinbaugh being pistillate or uni-sexual I deemed it possible to grow a cross between it and some other early blackberry, such as the Texas. I did not then think it possible to cross the *Rubus ursinus* with the Lawton, Kittatiny, or any other *Rubus villosus*, for the reason that the latter flower after the *ursinus*, and repeated trials of such a cross since that time have been failures with me. I had by the merest accident planted the Texas on one side of the Aughinbaugh and the red raspberry heretofore spoken of on the other. The canes of all three intermingled, and flowered and fruited together. For the purpose of securing an intermediate form between the Aughinbaugh and the Texas, I gathered and planted the seed of the former in August, 1881, expecting a cross between those two blackberries. A cross between the blackberry and raspberry was not then intended or even deemed possible by me.

I raised about fifty of these seedling plants. During the next season, 1882, I saw from the growth of the canes that the cross had produced something heretofore unknown. The canes of all except one were unlike anything I had ever seen before that time. The exception was a plant very similar in every respect to the Aughinbaugh parent, but very much larger and of stronger growth. This was the Loganberry. In the spring of 1883 I set the gardener to cultivate these plants. In doing so, by an unfortunate accident, the Loganberry plant barely escaped extinction. When he got through with it, there were but two or three buds left to fruit that year. The last of May, 1883, the fruit ripened, and then for the first time the extent of the creation was noticed. It has been repeatedly stated in public prints that I entertained the idea when I planted those seeds, of a cross between the raspberry and blackberry. I am sorry to disturb one of the supposed truths of history, but candor compels me to say that such is not the case. I did not then deem such a cross possible, and did not know what I had done until May, 1883, when the plant first fruited.

Subsequent observations of the Loganberry have confirmed me in the belief that it is entirely unique and distinct as a fruit. It is as much a new and in-

[1] Plants of this raspberry have been sent to this Station and an attempt will be made to determine the name of the variety.

dividual creation of the *Rubus* family as the blackberry or raspberry. Repeated plantings of the seed since that time have confirmed this individuality. Out of thousands grown from seeds not one has to my knowledge ever shown any of the distinct characteristics of either parent, not one has gone back to the original type of either the red raspberry or the Aughinbaugh blackberry. Most of the seedlings, to be sure, are inferior to the original, perhaps one in one hundred only has any merit whatever, but they are all, like the Loganberry, essentially a red blackberry, but similar in form of cane, leaf, time of ripening and sex of flowers to the original Loganberry. All my efforts, too, in the direction of crossing the Loganberry with either of its parents, or with the other seedling crosses between the Aughinbaugh and the Texas, have so far been failures.

The characteristics of the Loganberry as to shape and conformation of fruit, and the canes and roots, are essentially those of the Aughinbaugh. Unlike the raspberry parent they have no adventitious rootbuds, being propagated entirely by growth from the tips of the canes like the Black Cap raspberry. The fruiting canes are replenished each year by shoots from the crowns, which fruit and die yearly like all others of the *Rubus* family. The core remains with the fruit like the blackberry. Its principal similarity with the raspberry is in the color and the flavor, although the blackberry dominates in flavor as well as in all other characteristics except color. As to the fact of the plant being a hybrid between the blackberry and raspberry, of course there is no absolute proof. The color, with the distinct raspberry flavor of the fruit, and the circumstances under which it originated, I think render the fact of such a cross almost certain. Since then, too, the possibility of a cross between the raspberry and blackberry has been demonstrated beyond a doubt. At the same time as the origination of the Loganberry, and from the seeds planted with the seed that produced that fruit, another creation was produced in the *Rubus* family of very great interest. I have stated that from the seeds planted in 1881, about fifty plants came, of which the Loganberry was only one. These plants were crosses between the high bush Texas and the Aughinbaugh dewberry, and are in the blackberry family just as unique as the Loganberry. Most of the characteristics of this new blackberry are from the mother, the Aughinbaugh. Like the Loganberry, it has no adventitious rootbuds, but propagates from the tips only, the same as the Aughinbaugh and the Logan. The berry is very long—specimens have been found two and one-quarter inches, shining black, with the flavor of the *Rubus ursinus*. The canes are peculiar. They are covered with small spines, thickly interspersed and not very strong. The canes sometimes are one and one-quarter inches in diameter, and start up in the spring like the high bush, but when they get four or five feet high they start off with a trailing habit and sometimes grow over thirty feet long, and towards fall the tips seek the ground and root. One of the great characteristics of all these fruits is the fact that they ripen very early, generally beginning in this climate in the middle of May, six or eight weeks earlier than the earliest of the high bush varieties.[1] As to the adaptability of these berries to the different climates, I am not able definitely to say. The University of California has Experiment

[1] Plants in the Station garden have not yet fruited.

Stations in all altitudes in this State—high, low, hot, dry and moist. At all of these Stations they have the Loganberry, and the reports from all are that the berry is doing well. As I have before stated, the Loganberry is reproduced from seed, and while such seedlings are essentially Loganberries, not one in one thousand is equal to the original. Such seedlings are rank frauds when sent out as the Loganberry, and unprincipled nurserymen in this State, having in view only a little temporary advantage, have been flooding the East with such seedlings, and wherever sent the result has been condemnation of the Loganberry. It is like testing the merits of the Bellefleur apple by trees raised from its seed. That my statements herein may not be misunderstood, I wish to say that I have no pecuniary interest in the propagation or sale of this or any other plant or fruit, the control of it having long since passed out of my hands.

I send you to-day a photograph of the Loganberry fruit, grown in the open air in this city, January, 1897—the picture having been taken January 8, 1897. I do not send this to show that the fruit has any commercial value, for the purpose of growing in winter, but more for the purpose of showing the mildness of our climate where this fruit originated. The bulk of the fruiting of this plant is in May, June and July. However, the fall crop is often of considerable importance.

Sincerely yours,

J. H. LOGAN.

Santa Cruz, Cal., March 2, 1897.

PROPAGATION OF LOGANBERRY PLANTS.

With the modern means of communication, the fame of new garden plants now always precedes them, and if it is supposed that they are better than those of the same class already in cultivation they are propagated during the first few years of their existence as rapidly as circumstances will allow, because growers occupying a large area of the country all want them at about the same time. Frequently, as was the case with the Loganberry, the original stock consists of only a single plant. From this millions of others must be propagated if they are to go forth to all of those who are waiting with money in hand to give them a trial as soon as their marvelous qualities are properly set forth in nurserymen's catalogues, and personally explained and illustrated by agents who usually know nothing about them. This propagation of new plants has become an important branch of horticulture and now all kinds are multiplied with great rapidity; nevertheless some kinds can be increased much faster than others.

PROPAGATION BY STOLONS.

This is one of the slowest methods of propagating small fruit plants and unfortunately the Loganberry falls into the group of

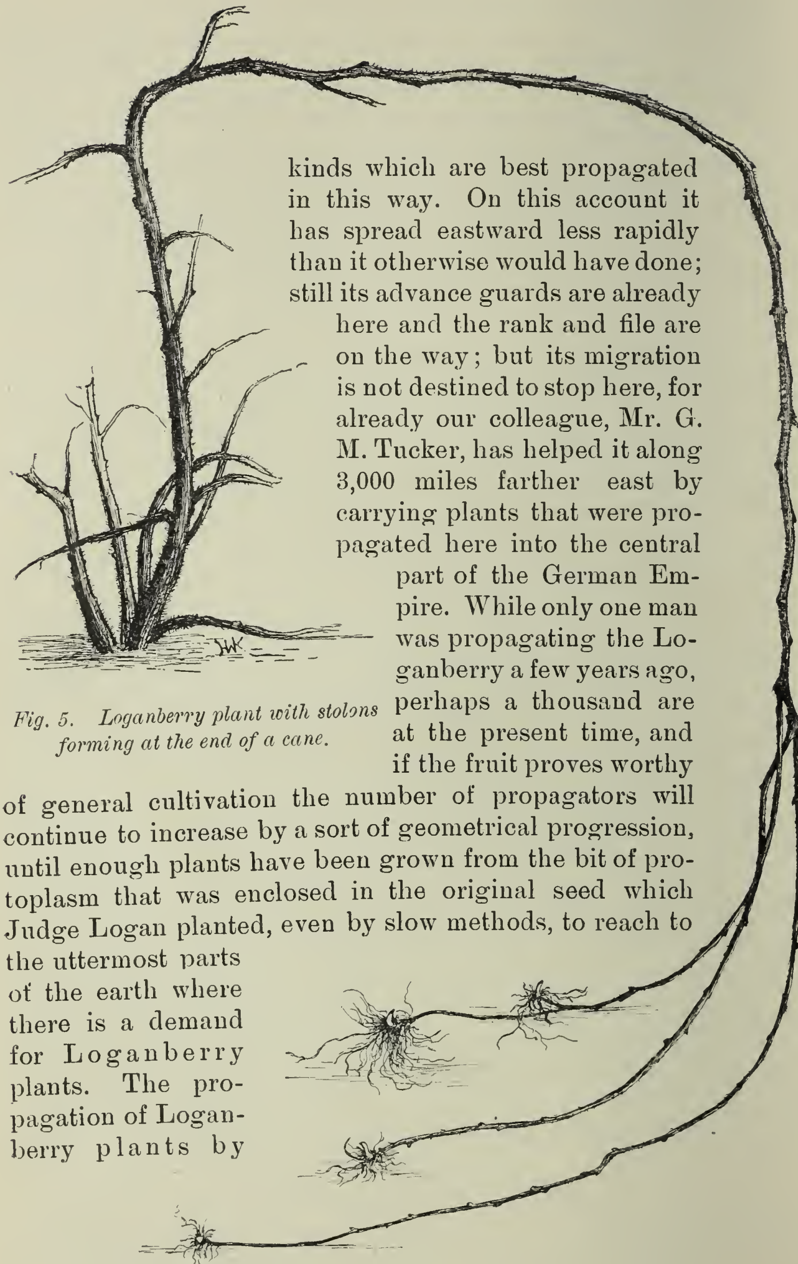


Fig. 5. Loganberry plant with stolons forming at the end of a cane.

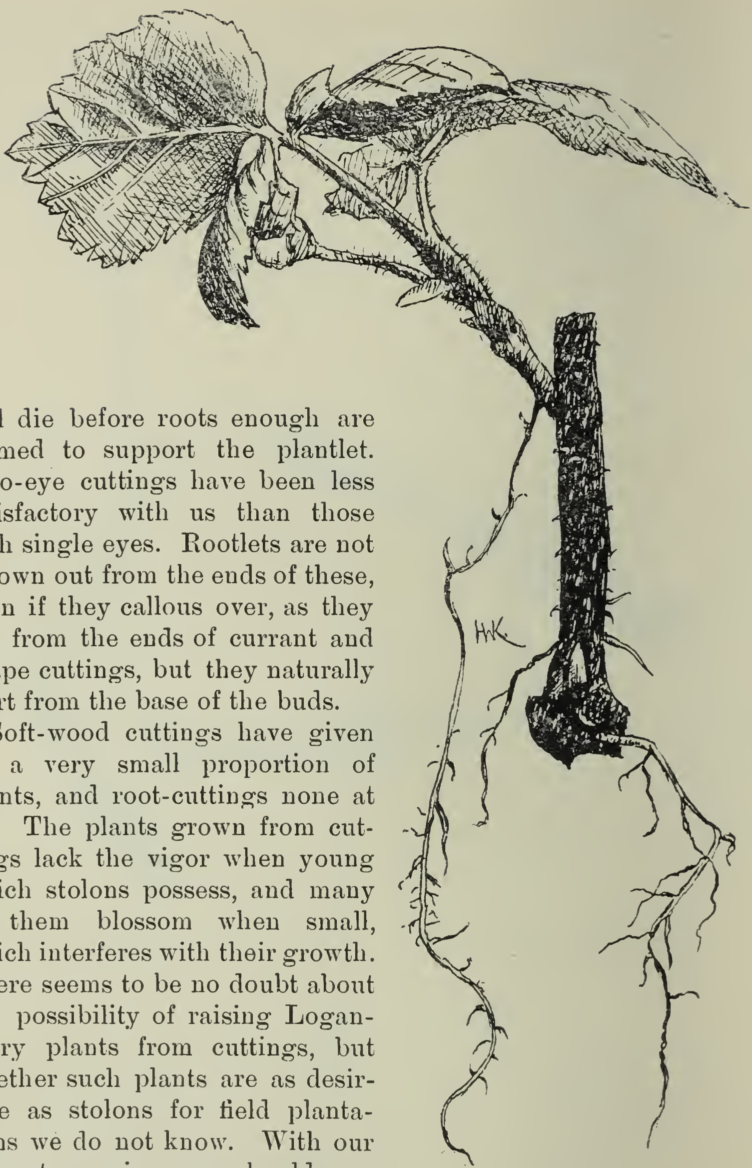
kinds which are best propagated in this way. On this account it has spread eastward less rapidly than it otherwise would have done; still its advance guards are already here and the rank and file are on the way; but its migration is not destined to stop here, for already our colleague, Mr. G. M. Tucker, has helped it along 3,000 miles farther east by carrying plants that were propagated here into the central part of the German Empire. While only one man was propagating the Loganberry a few years ago, perhaps a thousand are at the present time, and if the fruit proves worthy of general cultivation the number of propagators will continue to increase by a sort of geometrical progression, until enough plants have been grown from the bit of protoplasm that was enclosed in the original seed which Judge Logan planted, even by slow methods, to reach to the uttermost parts of the earth where there is a demand for Loganberry plants. The propagation of Loganberry plants by

stolens is not only comparatively slow, but it is an exceedingly awkward operation in the nursery. The canes are long, and at the Experiment Station they could not be induced to form roots until late in the fall, when a stolon developed at the end of each where they were properly covered. Black raspberry and Japan wineberry plants that were growing nearby, however, formed several times as many stolons with considerably less trouble, yet it is doubtful if any means of propagating the Loganberry can be profitably substituted for this which is provided by nature.

Fig. 6. Single-eye cuttings—three weeks after planting.

HARD WOOD CUTTINGS.

Loganberry plants can be grown from hard wood cuttings and with our limited experience this method of propagation would be our second choice, and perhaps it can be used in connection with the stolon method to advantage. If the mature wood is cut up into single-eye cuttings and these planted horizontally, rootlets are thrown out readily from the base of the buds, as shown in Fig. 6, but this stage is followed by a critical period during which they must be skillfully handled or a large proportion of them



will die before roots enough are formed to support the plantlet. Two-eye cuttings have been less satisfactory with us than those with single eyes. Rootlets are not thrown out from the ends of these, even if they callous over, as they are from the ends of currant and grape cuttings, but they naturally start from the base of the buds.

Soft-wood cuttings have given us a very small proportion of plants, and root-cuttings none at all. The plants grown from cuttings lack the vigor when young which stolons possess, and many of them blossom when small, which interferes with their growth. There seems to be no doubt about the possibility of raising Loganberry plants from cuttings, but whether such plants are as desirable as stolons for field plantations we do not know. With our present experience we should prefer the stolons, for there is little danger of this class of plants being too vigorous.

Fig. 7. Two-eye cutting—six weeks after planting.

SEEDLINGS.

Although varieties of vegetables are constantly propagated from seed, small fruits are not because it is known that their seeds cannot be depended upon to produce plants exactly like those upon which they grew. There are but few cases among small fruits where there is a temptation to substitute seedlings for plants propagated by approved methods, but the Loganberry seems to be one of these. The seeds germinate easily, the young plants are not difficult to raise, and if they were reliable this would be the most profitable way to increase the stock. But there is evidence to show that they are not reliable and that they should not be disseminated for planting purposes; still we are informed that they are already afloat in the trade and that they are certain to drift eastward. It is only necessary to recall the history of the cultivation of the Shaffer purple cane raspberry in New England, and we have an illustration of what may happen when there is a large demand for a plant that is propagated only with difficulty. The original Shaffer bush grew in a garden belonging to Mr. Geo. Shaffer, of Munroe County, N. Y., some twenty years ago. It was introduced by Mr. Chas. A. Green, and its merits as a market variety were soon recognized, but it was perhaps more difficult to propagate than the Loganberry. Seedling and other inferior plants were promiscuously distributed under its name, and soon brought about the premature decline of its popularity.

Fig. 8. Seedling Loganberry plant—three months old.

SUMMARY.

1. The Loganberry is the most promising new type of small fruit that has been grown at this Station.

2. It has been called a red blackberry with a slight but distinct raspberry flavor.

3. It is supposed to be a hybrid between a variety of the European raspberry and a variety of the wild blackberry of the Pacific coast.

4. Loganberry canes will probably not endure the New England winters without artificial protection.

5. The seed from which the original Loganberry bush grew was planted by Judge J. H. Logan, in Santa Cruz, Cal., in 1881.

6. The approved method of propagating the Loganberry is by stolons, yet the plants may be grown from hard wood cuttings.

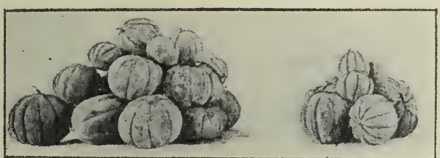
7. Loganberry seeds germinate readily but the seedlings are comparatively worthless when grown for fruit.

Duplicate,

Bulletin 46. August, 1897.

KINGSTON, RHODE ISLAND.

LIME AND LIMING.



CANTALOUPES.

LIMED. UNLIMED.

Agricultural Experiment Station

OF THE

Rhode Island College of Agriculture and Mechanic Arts.

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* The duties of the former Poultry Manager have been assigned to the Agriculturist.
† Five-sixths of time devoted to college work.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office—Kingston, Rhode Island.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 46.

LIME AND LIMING.

H. J. WHEELER.

According to early Roman writers, lime and land plaster (gypsum) were employed for agricultural purposes more than two thousand years ago. In the early part of the present century the use of carbonate of lime in form of marl was advocated by Ruffin in Virginia, who employed it with marked success. In England, Germany, France and other European countries, liming has long been resorted to with great profit upon certain soils. It is stated[1] that the soils of more than one-fifth of the entire area of France are derived from granite, and when the phosphoric acid and lime, which they lack, are applied, a complete transformation results, the character of the vegetation being so changed that good crops are obtainable where only meager ones were grown before. The same writers add that this has been one of the grandest conquests due to the intervention of science.

Some Recent Experience with Lime in the United States.

In certain sections of New York and Pennsylvania, liming has been and is still being practiced extensively, its use having proved especially profitable in connection with the wheat crop.

In 1896 Mr. O. H. Smith of Cattaraugus County, N. Y., as a

[1] Müntz and Girard, Les Engrais, Tome I, p. 70.

result of notices of our experiments, in the *Rural New Yorker*, became interested in the matter and upon request sent samples of his soil to this station to be examined for acidity. As a result of these examinations he was advised to use lime. These tests, in conjunction with others made by him with blue litmus paper, led him to make such a trial. A report of his experience is given in the *Rural New Yorker* of July 10, 1897, from which the following is quoted: "Were it not for our good grass, Cattaraugus County would be one of the most miserable counties in New York State. But of late years, for some cause, our meadows and pastures have become, in many instances, a failure. We have failed in getting our meadows and pastures to grow clover and Timothy as in years gone by. We prepare our land the best we know how, manure and fertilize all we can afford, and sow more seed than we did years ago. The clover and Timothy germinate and make a start, but as the months pass along, the seeding becomes thin, and as the years come around, the clover and Timothy have become minus for anything like a meadow. We can plainly see the effect, and we try to console ourselves by a cause. Sometimes we attribute it to the drought, at other times to the frost, then again the season was not right someway. . . . In 1896, I purchased a carload of air-slacked lime, thirty tons, spread the most of it on sixteen acres plowed the previous fall, sowed about one bushel of oats, three-fourths bushel of barley and one-half bushel of Canada peas per acre, and seeded with twelve quarts of Timothy and clover seed per acre, half and half. As to the grain, it was a good crop. The straw was of good length and stiff, the heads well filled; but the main thing I was after was clover, and I have it. There is not just a uniform mass of clover over the whole field, on account of incompetent help in spreading the lime; but as a whole field it's a fine show for a meadow. I have to-day cut clover and Timothy from one rod square which weighed one hundred and ninety-one pounds. The Timothy is not headed, few clover heads are to be seen, and it is still growing very fast. On the east side of the field I lacked lime to cover about one-half acre. The land was cultivated all alike, and fertilized three hundred pounds to the acre. Where there was no lime, at the opening of spring not a spire was to be seen. Right from the start of the lime, the contrast is very marked. Through the middle of three acres, we left a few paces unlimed, except what the wind blew when being spread, and perhaps a little harrowed through it by cultivating.

It's no meadow. I have now limed all the unlimed parts and seeded to clover. Some portions of the south end of the field were not properly limed, and the contrast is apparent. There is on three acres out of the sixteen, more actual cattle food standing on the ground to-day, June 17, than there has been in any five years since I have owned the farm—twenty-eight years.

"Another very marked and striking difference is that, where the lime was evenly put on, and plenty of it, no sorrel is to be seen. On the other hand, where the lime was unevenly spread, the sorrel is quite visible. Now the land above described was cultivated, fertilized, and last fall a light dressing of barn-yard manure was spread on the limed and unlimed all alike, not to exceed ten two-horse loads to the acre, and the marked result is that where limed, there is a large growth of Timothy and clover; where there was no lime there is no meadow."

By the use of lime on the farm of the Experiment Station at Maryland, wheat and succeeding crops of Timothy and clover have been wonderfully increased.

The farm of our own Station at Kingston has by its use been brought from its former miserable condition to a high state of productiveness, while by the use of fertilizers and moderate applications of stable manure only, seeding to Timothy and clover had previously resulted in failure.

Many Plants Need Lime on Acid Soil.

In the course of the experiments already conducted at this Station, more than one hundred varieties of plants have been tested to find out what effect lime has upon their growth, and while a few are injured by it, particularly if they are grown the same season that the lime is applied, most of the plants usually grown in Rhode Island are either uninjured by liming or else benefited in a greater or less degree. The great benefit from lime upon the farm of the Experiment Station having been established, further experiments were conducted for the purpose of ascertaining if the form or combination in which the lime is applied to the soil has anything to do with its effectiveness. The various experiments conducted for this purpose have shown that lime, to be of the greatest possible use, must be applied to the land in the form of air or water-slacked lime, or of calcium carbonate (carbonate of

lime). When applied in the two first-mentioned forms, most of the lime passes sooner or later, in the soil, into the form of carbonate of lime.

Having ascertained that carbonate of lime and such other forms as are readily changed into the carbonate within the soil were effective agents in improving the soil at Kingston, our attention was next devoted to ascertaining to what extent other soils in the State were in a similar condition.

BENEFICIAL EFFECT OF LIMING QUITE GENERAL IN RHODE ISLAND.

In experiments with sulfate of ammonia at Hope Valley, R. I., on the farm of H. E. Lewis, in which a similar ill effect was noticed as at Kingston, air-slacked lime was fully efficacious in correcting the condition and in causing the sulfate of ammonia to act as a valuable manure, thus showing that similar soil conditions existed as in Kingston.

In 1895, two plots on the farm of F. P. Babcock, at Westerly, R. I., were manured alike with superphosphate, muriate of potash and nitrate of soda. One was limed and the other not, and mangel wurzels were sown upon each plot. To all appearances the seed germinated equally well on both plots, but with the advance of the season some of the plants on the unlimed plot turned red and gradually died without making further growth. Toward the end of July there was already quite a noticeable difference in the size of the beets on the two plots, and at the time of harvest there were obtained from the unlimed plot 63 pounds of beets, and from the limed one 155.5 pounds. Mr. Babcock had stated, some two years before this experiment was tried, that on certain portions of his farm, beets, spinach, and lettuce did not succeed as they should, and these results seemed to afford an explanation of the reason for this partial failure.

In 1896 Mr. Babcock employed lime to some extent in his gardening operations and makes the following report in relation to his experience: "I have raised beets for the past six years with rather poor success. We had to fertilize very highly and market them as soon as they were large enough or they would grow stringy and lose their sweetness. After an experiment last year with lime I concluded to use it on my beets this season. I used about twelve barrels to the acre, slacking with water, using just

water enough to leave it dry and fine like meal. We spread it after plowing, and mixed it with the soil by harrowing. The seed germinated much better where the lime was used[1] and the beets were at least ten days earlier for the market, being of the finest quality. As the season advanced they grew to be immense in size but retained their good qualities to the end of the season.

"In conclusion I would say, that if the farmers of Rhode Island would give lime a trial on beets of all kinds, also in seeding to Timothy and clover, they would be surprised at the results."

In experiments with beets, conducted in 1896, in various sections of the State, upon plots of like area equally fertilized with superphosphate, muriate of potash and nitrate of soda, a benefit from liming was noticeable in every case but one.[2]

At Warren, upon the farm of George W. Arnold, where the soil seemed to be nearly neutral or alkaline, the gain of table beets upon the limed plot amounted to 21 per cent. At Harrisville, upon the farm of W. E. Fitz, the soil of which was but slightly acid to blue litmus paper, the gain was 37 per cent. On the Island of Conanicut, upon the farm of E. N. Tefft, and at Summit, upon the farm of B. H. Nixon, the crop was almost doubled. At Niantic, on the farm of E. W. Vars, the crop was increased more than four times. On the Island of Rhode Island, at South Portsmouth, upon the farm of N. Horace Peckham, the crop was increased nearly six times. At Hamilton, on the farm of Geo. H. Larned, the crop was increased nearly nine times, while at Slocumville, upon the farm of Alfred Eldred, and at Kingston Hill, upon the two soils most acid to blue litmus paper, and yielding the largest amount of humous material directly soluble in ammonia, the yields of beets were increased enormously in comparison with any of the cases cited above.

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1 From many observations made elsewhere, as well as from careful observations on the mangel wurzels on Mr. Babcock's place in 1895, we are inclined to believe that the difference was not to any extent one of germination but was caused largely by the dying of many of the small plants on the unlimed land, a point which could easily have escaped detection.

2 The exception was upon a field on the place hired by R. C. Nichols of Hope Valley. The field, which had been in mowing or pasture, contained much Wild grass (*Andropogon scoparius*, Mx.), on account of which the sod was so tough that it was impossible to satisfactorily mix the lime with the soil. This fact, together with the lightness of the soil and the existence of a severe drouth when the seed was sown, seem to explain the unfavorable action of the lime. At Niantic, upon an equally light soil which was naturally more moist, and where the lime could readily be mixed with the soil, the results from the use of lime were good.

Clover and Timothy Greatly Helped by Lime.

Experiments have been continued in 1897 at Summit, Foster Centre, Harrisville, South Portsmouth, Conanicut, Hamilton, Slocumville and Kingston *Hill*, with clover and grass, and in each case, excepting that of the Harrisville soil, marked benefit from liming has resulted in connection with clover and Timothy. At Slocumville, Kingston Hill and Summit, where the clover upon the unlimed plots looked as good or better at the outstart than upon the limed ones, many of the plants, with the advance of the season of 1896, turned yellow and died, so that the crop in 1897 was practically a failure upon the unlimed plots. In the same experiments, as well as in many others at Kingston, the ability of clover to gain the upper hands of sorrel upon limed plots has been abundantly demonstrated. Where Timothy and Redtop have been found together, liming has invariably increased (and usually to a great extent) the relative percentage of the former, and so great has been the difference upon some of the experimental plots, that the market value of the hay, per ton, upon the limed plots has been estimated by farmers who have seen it, at two dollars greater than that upon the unlimed ones.

From what has preceded, it must be obvious that there can no longer remain a question but that much of our Rhode Island soil is probably lacking in carbonate of lime. It must therefore be evident that the great benefit usually derived from wood ashes is not, and cannot be attributable, almost solely to the potash which they contain, but in a large degree also to their high percentage of lime. The recognition of this value of lime would have less practical significance if we could be assured of continued unlimited supplies of wood ashes at a low price. This does not, however, appear to be the case, since the agricultural investigators of Canada, from whence most of our ashes come, are calling the attention of their people to the fact that these ashes should be kept at home, and there is little prospect that their supply and price will preclude the profitable substitution, in many cases, of lime and agricultural chemicals.

Chemical Action of Lime.

Lime unites with acid substances in the soil, by which the soil is sweetened or its natural acidity (sourness) overcome or reduced.

In case certain injurious iron compounds are present in soils, these are so transformed by lime as to be rendered harmless. It also acts upon potash compounds in the soil in such a way that the lime takes the place of the potash, setting the latter free for the use of plants.

If lime is present in a soil to which ordinary commercial fertilizers, dissolved boneblack, dissolved bone, dissolved phosphate rock, or double superphosphate, have been added, it is probable that some of the soluble phosphoric acid will further combine with lime, in which condition it would be expected to be more readily available to plants than would have been the case had lime been absent, and a more favorable opportunity been given for all of the phosphoric acid not quickly utilized by the plants to combine with iron and aluminum oxids.

BIO-CHEMICAL[1] EFFECTS OF LIME.

The presence of lime in soils favors the decomposition of the organic matter which they contain, and in this process carbonic acid is produced which in turn acts upon the ingredients of the soils in such a way as to render the natural plant food much more readily assimilable. It plays, likewise, an important part in facilitating the change of ammonia into nitric acid, or in other words, in placing at the disposal of plants the stored up nitrogen of the soil, as well as that applied to or left in it, in the form of animal manures, meat, blood, fish, plant roots, etc.

Clover, alfalfa and certain other of the plants which have the power of drawing their nitrogen supply chiefly from the air within the soil, are unable to make a satisfactory growth and to thus utilize the vast amount of nitrogen about them, provided the soil exceeds a certain degree of acidity, but by the application of lime they are made to thrive and to gather for the farmer stores of nitrogen, for which he must otherwise pay a fertilizer dealer (at present prices) at the rate of about thirteen cents per pound.

It should be stated that it is probable that *excessive* amounts of caustic lime might prove injurious to these plants which are ordinarily helped by it, particularly if the soil were but slightly or not

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[1] Bio-chemical is a term used in speaking of chemical changes in which living organisms (plants or animals) have a part.

at all acid. Such a conclusion seems to be justifiable in view of the injurious action of considerable quantities of caustic lime upon the growth of peas and allied plants, as noticed by Salfeld.[1] Experiments by Hellriegel, Heinrich, and others in Europe, accord with our own results with lupine in this particular, and Salfeld seems to have shown conclusively that the ill effect is due, as assumed by us in connection with the lupine experiments, in part, probably, to an injurious action of the lime upon the minute organisms which cause the development of the nodules upon the roots and by the agency of which the plants are enabled to assimilate atmospheric nitrogen.

LIME UNFORTUNATELY FAVORS THE GROWTH OF THE POTATO SCAB FUNGUS.

Another minute organism, the growth of which is favored by moderate quantities of lime, is the potato scab fungus, which by its development upon the surface of potato tubers causes them to become scabbed or covered by rough and more or less deep excrescences. On this account liming in a rotation which includes potatoes should be indulged in but moderately if at all, and the application should follow the potato crop immediately, or better, a year later, and never immediately before the potatoes are grown. In all cases where potatoes are grown upon limed land the previous treatment of the seed tubers with corrosive sublimate, formalin, or other effective germicide should never be omitted. Methods for this treatment are here given:

Bolley's Corrosive Sublimate Treatment.

Corrosive sublimate can be bought at drug stores in the form of crystals. Two and one-fourth ounces of these crystals should be dissolved in a few gallons of hot water, and enough cold water added to make fifteen gallons of solution; the whole should then be well stirred. In preparing the solution and treating the seed, use wooden vessels only. Two barrels with wooden faucets are convenient, the solution being drawn from one to the other whenever it is desired to remove the potato tubers. The tubers may also be put into a sack and dipped into the solution. The same

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[1] Die Boden Impfung, Bremen, 1896, pp. 79-83.

solution may be used a number of times. The whole tubers, after first being washed, should be placed in the solution for one and one-half hours, then spread out to dry, and cut and planted as usual. It must be borne in mind that corrosive sublimate is a powerful poison if taken internally, and none of the solution should be poured out near wells or where fowls, etc. can obtain any of it, nor should the vessels be used for any other purpose. The solution of the strength employed will do no harm externally on the hands, but great care should be used not to get any of it into the mouth.

Arthur's Formalin Treatment.

It is stated by Dr. J. C. Arthur[1] in relation to this treatment, that "It is equal to corrosive sublimate treatment in efficiency and is without its dangerous and troublesome properties." The treatment is as follows: Add eight fluid ounces (about one-half pint) of formalin to fifteen gallons of water, and soak the seed tubers in it for two hours before planting.

The sulfur treatment for contaminated soil and seed, advocated by Halsted[2] in one year's trial at this Station has not proved satisfactory as a means of disinfecting the soil. Arthur states[3] that experiments by him in 1890 "in which sulfur was placed in the hills at time of planting" showed no marked advantage from its use, and he further cites experience of Bolley[4] to the same effect.

No method of treating seed tubers can be expected to prevent scab on the crop, if the soil is already badly contaminated with germs and is favorable to their development. Where the soil is free from contamination, or but slightly contaminated, the corrosive sublimate treatment has been abundantly shown to be effective. The formalin treatment has not as yet been extensively tried, nor have tests of it been made at this Station. It seems probable, however, from its general efficacy as a germicide that it may prove to be all that is claimed for it by Arthur.

The injury from the disease known as "finger and toe" or "club root" may be prevented or greatly decreased by the use of lime, and good turnips are said to have been grown upon limed

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[1] Bull. 65, Purdue University Experiment Station, Indiana, p. 32.
[2] Bull. 112, New Jersey Agrl. Expt. Station, 1895.
[3] Bull. 65, Purdue University Agrl. Expt. Station, Indiana, p. 20.
[4] Proc. Soc. Prom. Agric. Sci., 1896, p. 81, cited from J. C. Arthur.

land which before the treatment would not produce a respectable looking crop.

PHYSICAL EFFECTS OF LIME.

Lime applied to stiff clays causes them to become more friable, more permeable to the air, easier of tillage, and better capable of supplying water to plants as needed. Sandy soils, on the other hand, are rendered by it more compact and more retentive of water and fertilizers. On very dry, sandy soils, smaller applications of lime must be made than upon moist ones, and the use of large quantities of lime upon such soils, in single applications, is inadvisable.

WHEN TO APPLY LIME.

For the reason that lime while in its caustic state is injurious to certain crops, and by lying in the soil its causticity is soon lost or materially decreased, it is evident that the ideal time to apply it would be in the autumn. When autumn seeding is practiced, either with grass alone or in connection with winter rye, the lime should be sown upon the furrows after plowing and then most thoroughly harrowed in, for the degree of benefit from liming will depend to a great extent upon its even distribution and complete incorporation into the surface soil. Where seeding Indian corn fields to grass at the last hoeing, is practiced, as is common in the Connecticut Valley in Massachusetts, it would be advisable to apply the lime in the manner outlined above after plowing the land in the spring for the Indian corn crop. Under other circumstances it is probably better not to lime just before Indian corn or rye, for these crops are liable to be slightly injured by fresh applications of lime, some of which is in the caustic state. In the case of rye there may be a slight increase in grain, which would offset to some extent the slight loss on the straw, while with Indian corn the maturity of the crop is usually hastened by liming, sometimes even nearly a week, so that it is less liable to injury by early frosts and more time is given in the autumn after the removal of the corn for the grass to gain a firm foothold before the advent of winter.

If the lime is thoroughly worked into the soil it may be applied in the spring, for certain plants, with little or no risk and usually

with great advantage. This seems to hold true of beets of all kinds, lettuce, spinach, cauliflower, kohl rabi, onions, muskmelons, cantaloupes, salsify, cabbages, peppers, and many other plants. The experiments thus far conducted indicate that ordinary millet, golden millet and Hungarian grass should be sown if possible a year or more after liming. *These statements in relation to care in liming just prior to growing rye, Indian corn and millet, apply to cases where the nitrogen supply is chiefly in the form of nitrates, such for example as nitrate of soda, and where the soil conditions naturally induce rapid nitrification of the soil nitrogen, or of the nitrogen applied in natural and artificial manures, such as ammonium salts or organic matter.*

If the soil is very sour and nitrates are not employed, then the use of lime immediately before these crops may prove of great service, for the reason that the benefit derived from the lime by virtue of its facilitating the transformation of the nitrogen into a form immediately assimilable by the plant, may far outweigh any direct injury that the lime might otherwise have exerted. In certain of our experiments, under such conditions, where the soil was very acid, the use of lime directly before these crops has proved highly advantageous but where an abundance of nitrate of soda was applied such was not the case. In view, however, of the fact that most of the commercial fertilizers employed contain but limited amounts of nitrates, it is to be concluded, provided the soil is very acid, that the safer plan would be to use the lime even before these crops, provided the land had not been limed for several years and stood greatly in need of such treatment.

Shall Liming be Practiced More Than Once During a Rotation?

In ordinary rotations, extending over intervals of from five to seven years, it will probably seldom be necessary to lime more than once during the rotation. If beets, onions, cucumbers, spinach, muskmelons or some other crop particularly helped by lime, were to be grown as a part of a rotation, upon a farm devoted to both general farming and market gardening, it might be advisable to resort to an extra liming for the sake of these crops, though unless the soil were very deficient in lime this might not be necessary. Where meadows are kept in grass for long periods, and where annual top dressing with stable manure is not resorted

to, but in its stead frequent dressings with ordinary commercial fertilizer, an additional liming upon the grass might be desirable at intervals of five or six years.

How Much Lime Should be Applied at Once.

The quantity of lime to apply at a single application cannot be definitely stated for all soils and crops, since it would range under varying conditions from half a ton, to three, or possibly four tons per acre. The old English practice of liming heavily at rare intervals has given way of late years to the use of smaller quantities applied more frequently. This is due to the fact that lime gradually dissolves out of the soils and escapes into springs and streams. In the case of light, dry, sandy soils the range of application would usually be from one thousand pounds to one and a half tons per acre, according to their apparent need. On heavier soils, from one to three tons per acre is the usual range. On old pastures or meadows well covered with moss, certain writers advise spreading some lime upon the surface a while before plowing in order to better effect the decomposition of the sod. Whether or not this practice is preferable to that of applying all of the lime to the surface after plowing, we are not prepared, from our own observations, to say, but can affirm that the latter practice yields excellent results. Upon breaking up such old fields, provided the soil is fairly heavy, one and a half to two tons of lime may be applied to advantage as just mentioned, and two or three years later a like amount may be employed just prior to reseeding to grass. If such treatment is resorted to at the outstart, applications of from one to two tons per acre or less, at intervals of from five to seven years, should maintain fields in good condition. It cannot be expected that fields that have been abused for years can be restored at once without some little extra outlay for lime, and it is not economy to attempt to accomplish the task by the use of such small amounts of stable manure as many farmers now have at disposal, or by resort to commercial fertilizers unless enough lime is employed to put the land in condition so that the crop can utilize what is offered it. It is obvious that the first round of a rotation will yield less profit than the second and succeeding ones, but notwithstanding the fact that considerable expense is involved at the outstart, such sour, mossy, and practically abandoned fields if

reasonably easy of tillage, may, even at the present time, be brought into good condition at a profit. By the use of lime, clover is made to thrive where it refused to grow before. This if utilized upon the farm constantly increases the store of nitrogen in the stable manure, and reduces first the amount of concentrated cattle foods such as bran, cotton-seed and linseed meal which must be bought, and finally, the amount of nitrogen required in the form of artificial fertilizers, so that the outlay for lime on such lands is soon saved.

Upon moderately heavy land from one to two tons of lime per acre, once during a rotation covering from five to seven years, will accomplish all that is to be desired.

If the habit of practicing regular rotations of crops and of annually top-dressing mowing fields were more generally adopted, there is no doubt but that the outlook for Rhode Island agriculture would be better. It costs about as much to mow and rake an acre which yields five hundred pounds of hay as one yielding three tons, a point which is too frequently forgotten. The same principle applies to other crops as well. System must be employed as in other business if farming is to prove profitable.

THE EFFECT OF LIMING UPON THE GROWTH OF VARIOUS PLANTS.

Below are given lists of those plants which have been tested at this Station, during the last four years, for the purpose of ascertaining the effect of lime upon their growth. For each year the plants are arranged in the order of their apparent benefit from liming, that most benefited being at the top. Under those apparently injured by liming that least injured is arranged at the top and so down in regular order to the bottom, where the one most injured is to be found. Where the figures at the right are greater than 1.0 they indicate benefit from liming, where they are less than 1.0 they indicate injury. The figures 5.5 at the right would indicate that the crop had been increased five and one-half times by liming, while .25 at the right would indicate that but one-fourth as much was obtained from the limed plot as from the other. In one case the figures for Blue Lupine are .23, indicating that less than one-fourth as much was produced upon the limed as upon the unlimed plots. These results were secured upon plots well fertilized annually with like amounts of dissolved boneblack, muriate of potash

and nitrate of soda, and in addition, in 1895 and 1896, with sulfate of magnesia (Epsom salts). Had other forms of nitrogen like sulfate of ammonia, fish, meat, blood, etc., been used, even greater differences in favor of the limed plot would have been obtained, as has been abundantly shown in other of our experiments. Nitrate of soda was employed in generous quantities in this case, to eliminate, in so far as possible, any benefit which might have been derived from the lime in facilitating the nitrification of the soil nitrogen so that the results might indicate as nearly as possible the benefit from the lime in correcting the chemical and physical conditions of the soil.

YEAR OF 1893.

Benefited by Liming.

Lettuce	77.93
Spinach	24 75
French Sugar Beet	12.17
Golden Tankard Beet	10.75
Amber Sugar Cane	10.59
Eclipse Table Beet	7.78
Long Red Mangel Wurzel	7.59
Kaffar Corn	3 40
Jerusalem Corn	2.41
Late Cabbage	2.37
Sweet Corn (Maize)	2.07
Rutabaga (early sown)	1.83
Barley	1.80
Victoria Carrot (yellow)	1.78
Mastadon Carrot (white)	1.76
Buckwheat	1.65
Pop Corn (Maize)	1.56
Granger Pea	1.53
Kale	1.51
Tomato	1.40
Crimson Clover	1.35
Rutabaga (late sown)	1.32
Panicum crus-galli	1.31
Early Cabbage	1.28
Oats	1.26
Dent Corn (Maize)	1.17
Rye	1.13
Sunflower	1.09
Golden Millet	1.04
Early Rose Potatoes	1.03

Injured by Liming.

Common White Bean	.94
Hungarian	91
Italian Millet	.87
White Podded Adzuki Bean	.82
Cow Pea	.80
White Capped Corn (Maize)	.71
Blue Lupine	.47

YEAR OF 1894.

Benefited by Liming.

Spinach	61.00
Gumbo	11.38
Sugar Beet	11.00
Lettuce	10.00
Salsify	9.50
Celery	9.42
Red Onion	9 00
Globe Mangel Wurzel	8.21
Yellow Onion	8.12
Parsnips	6.99
Long Mangel Wurzel	5.77
Table Beet	5.35
Muskmelon	4.70
Late Cabbage	4.60
Tobacco	4.52
Egg Plant	3 75
Cauliflower	3.70
Cucumber	3.02
Sorghum	2 99
Martynia	2.84

Pepper	2.74
Peanut	2 53
Barley	2.06
Rape	1.97
Red Clover	1.70
Potato (Beauty of Hebron)	1 67
Garden Pea	1 65
Kohl Rabi	1.59
Golden Wax Bean	1.58
Brussels Sprouts	1.57
Buckwheat	1.53
Rutabaga	1.46
Tomato	1.42
Sunflower	1.42
Spring Wheat	1 40
Radish (Long Scarlet)	1.37
Turnip (Purple Top)	1 29
Cabbage (early)	1 24
White Carrot	1.18
Turnip (Early Red Top)	1 15
Kale	1.15
Sweet Corn	1.11
Oats	1.09
Dandelion	1 08
Soja Bean	1.06
Potato (Early Rose)	1 05
Spring Rye	1 03

Injured by Liming.

Cow Pea	.94
German Millet	.90
White Podded Adzuki Bean	.88
Common White Bean	.88
Radish (French Breakfast)	87
Golden Millet	.87
Carrot (Long Orange)	.74
Carrot (Danvers)	.71
Watermelon	.64
Indian Corn (R. I. Cap)	.61
Pumpkin	.55
Common Sorrel	36
Blue Lupine	.23

YEAR OF 1895.

Benefited by Liming.

Onion (Egyptian)	31.00
Celery	27.60
Onion (Barletta)	7.88
Pumpkin	5.36
Beet (Mangel Wurzel)	4.95
Alfalfa (first crop)	3.68
Barley	3.58
Muskmelon	2.45
Carrot	1 96
Spring Wheat	1 91
Sweet Corn (Maize)	1 89
Table Beet	1.84
Dandelion	1.74
Cabbage	1.70
Kohl Rabi	1.60
Kohl Rabi (transplanted)	1 57
Awnless Brome Grass	1.55
Alfalfa (second crop)	1.49
Flat Turnip	1.34
Meadow Fox-tail (grass)	1 30
Tall Fescue (grass)	1.24
Kentucky Blue Grass	1.20
Red Top (grass)	1 17
Orchard Grass	1.16
Meadow Oat Grass	1.09
Oats	1 07
Field Corn (Maize)	1 06
Pop Corn (Maize)	1.03
Meadow Soft Grass	1 01
Sheep's Fescue (grass)	1.00

Injured by Liming.

Rhode Island Bent (grass)	.99
Sweet Vernal Grass	.89
Millet	82
Common Sorrel	.82
Rye	.75
Serradella	.69
Blue Lupine	.61
Watermelon	.55

YEAR OF 1896.

Benefited by Liming.

Spinach	20 50
Carrot (yellow, south row)	6.67
Beets (Mangel Wurzel)	5.73
Barley (late sown, north row)	3.71
Dandelion	2.83
Barley (early sown, south row)	2 63

Barley (early sown, north row)	2.01	Rhode Island Bent (grass)	1.18
Barley (late sown, south row)	1.89	Meadow Soft Grass	1.17
Crimson Clover	1.59	Meadow Oat Grass	1.16
Sheep's Fescue (grass)	1 51		
Rye	1 38	*Injured by Liming.*	
Timothy (grass)	1.22	Red Top (grass)	.94
Kentucky Blue Grass	1 21	Gladiola (bulbs)	87
Awnless Brome Grass	1.21	Blue Lupine	.77

In connection with the above observations, it should be stated that the limed plot received its first application of air-slacked lime at the rate of 5400 pounds per acre in the spring of 1893, and a second one at the rate of 1000 pounds per acre in the spring of 1894. During 1895 and 1896, no further applications were made, so that the results obtained in those years indicate its action after all or nearly all of it had probably been changed into carbonate of lime.

HOW TO ASCERTAIN IF A SOIL WILL BE HELPED BY LIMING.

Soils which contain any considerable amount of carbonate of lime are either neutral in their action upon litmus paper or, as is usually the case, they are alkaline. If a soil were neutral it would not change the red tint of a red litmus paper to a blue one, nor vice versa. An alkaline soil will change a red litmus paper so that it will become blue, and an acid soil will cause a blue litmus paper to become red. This test can be made as follows: A tablespoonful or more of soil is placed in a tumbler or cup and moistened with sufficient water to make the mass of about the consistency of a thick paste. It is best to allow it to stand for from fifteen to twenty minutes before making the test, though it may be made at once. With a knife blade part the soil and introduce one end of a slip of *blue litmus paper*,[1] which may conveniently be about one-half to three-quarters of an inch wide and two inches long, press the soil about the paper and after from two to five minutes remove the paper without tearing it, rinse off the adhering soil with water and note whether it still retains a blue tint or has become positively red. If the paper has been strongly reddened it may be concluded that lime will probably benefit many crops which may be grown upon the soil. If the soil has a marked reddish tint, as is sometimes the case, it may be better to bring but

[1] A few cents will buy enough at any apothecary store to make many tests.

one side of the paper in contact with it, and if a red color comes through to the other side it may be concluded that the soil is acid. In all cases care must be taken not to handle the end of the paper which is used for making the test, since the touch of the fingers may redden it and thus one might be deceived.

In case a soil contains any considerable excess of carbonate of lime and magnesia, the humus is mostly combined with lime and magnesia, and in such a case if a teaspoonful of soil is stirred into a glass of water to which a few drops of *ammonia water*[1] have been added, and the whole set aside for some hours, the liquid which remains at the top will be nearly colorless, but where lime and magnesia are lacking in a soil the liquid has usually a dark brown or black appearance, the intensity of color depending upon the amount of soil taken, and of course upon its need of lime.

If one has made one or both of these tests and desires to make a trial of lime in a small way at the outstart, the beet test is to be recommended since beets show benefit from liming in a very marked manner in case the soil really needs such treatment. To make such a test one should select two plots of land as near alike as possible, and where previous crops have apparently been uniform (a better way is to test the uniformity of the unmanured plots beforehand, which takes an extra year). Plots thirteen and one-half by twenty-seven feet are of a convenient size. They should be separated by a path six feet wide. Forty-one pounds of lime (about $2\frac{1}{2}$ tons per acre) should be applied to one of the plots and raked in, after which a like quantity of any kind of fertilizer should be applied to each plot. It is usually better as described above to put the lime on and work it in well before sowing the fertilizer, which in turn should be thoroughly raked in. This plan not only lessens the probability of any of the fertilizer coming in contact with the lime at the surface of the soil, by which, in case ammonium salts were present, some loss of ammonia might result; but it furthermore insures a better mixing of the lime with the soil, which is a very important factor. A like weight of any kind of beet seed should be sown upon each plot. Where the soil is very sour and unlimed the seed will usually germinate, but many of the young plants die early. After several weeks one would think more seed had germinated upon the limed than upon the unlimed plot.

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[1] This is to be had of any apothecary for a few cents.

WILL LAND PLASTER HAVE THE SAME BENEFICIAL EFFECT AS AIR OR WATER-SLACKED LIME?

If the beneficial action of lime upon a soil is due solely or chiefly to its having liberated potash for the use of the plants, then gypsum or land plaster (sulfate of lime) would probably act with equal or greater energy. In the case of our acid soils it has proved in some trials of great benefit, but usually far less beneficial than like amounts of lime (calcium oxid) in form of air or water-slacked lime. This seems quite reasonable when it is borne in mind that in the form of land plaster, lime is already combined with a strong mineral acid, sulfuric acid (oil of vitriol) and could not for this reason combine with the acid compounds of the soil, as air and water-slacked lime and the carbonate are able to do.

FORMS OF LIME WHICH ARE AVAILABLE IN RHODE ISLAND FOR FERTILIZING PURPOSES.

Land plaster or gypsum requires no further mention after what has been said above, since it is a form of lime with which all are familiar.

Superphosphates such as dissolved bone, dissolved boneblack and dissolved phosphate rock, have been made by treatment of the original material with sulfuric acid (oil of vitriol) after which about two-thirds of the lime which they contain is combined with the acid in the form of land plaster, so that whoever uses superphosphates or ordinary commercial fertilizers containing soluble phosphoric acid applies land plaster at the same time.

Phosphate of lime in the form of raw ground or steamed bone, guano, phosphate rock (also sold as "floats" and under other names), consists of lime in combination with phosphoric acid. Such material is said to work much better upon acid soils than upon others, for the reason that the acid compounds of the soil seize upon or unite with some of the lime, by which the phosphoric acid which they contain can much more readily be taken up by plants. It can for this reason, aid in lessening the sourness of soils and may on this account act more beneficially upon extremely sour soils than superphosphates, provided no lime is used in connection with the latter.

Basic slag (Thomas slag or slag meal) is a residual product re-

sulting from the manufacture of steel from phosphate of iron. There exists some difference of opinion in relation to it, but it is more generally held that it contains proportionately more lime in combination with phosphoric acid than is the case with ordinary phosphate of lime, and that it usually contains lime aside from that so combined. If such is the case, which seems to be true, it would be expected to act more effectively upon acid soils than the ordinary phosphate. The phosphoric acid which it contains is likewise, chiefly in a very assimilable condition.

Unleached wood ashes have been bought in this State in the past, chiefly on account of the potash which they contain. The amount of this ingredient present is usually from five to seven per cent. Aside from this they contain from one to two per cent. of phosphoric acid, the exact value of which does not seem to be settled, also from three to five per cent. of magnesia, which is useful on many soils, and about thirty-five per cent. of lime.

Leached wood ashes and lime-kiln ashes contain relatively less potash and more lime than unleached ones. The amount of potash in leached ashes often ranges from one-half to one per cent. In lime-kiln ashes the potash present is often as high as two per cent. or more, though where coal is used in burning lime they would contain little or no potash.

Gas-house lime which was formerly obtainable is now seldom to be had, owing to changes in the process of gas manufacture by which the use of lime is avoided. It should always be weathered some months before using. It cannot act as efficaciously as ordinary slacked lime, nor as lime in wood ashes.

Dye-house lime, which collects as a waste product at certain dye houses, is useful, its value depending upon the ease with which it may be incorporated into the soil, and upon its percentage of lime. If it contains a low percentage of lime, as is usually the case, (one such sample tested here contained about 21 per cent.) it would not pay to transport it long distances, but it could be used economically, provided the soil required it, by those near the works or where the cost of transportation by freight is low.

Finely ground limestone and oyster shells may be used to advantage if they can be had, but they cannot readily be obtained in as fine a state as lime which has been burned, nor would the effect be as good upon most soils. Upon light, naturally dry, sandy soils their use would probably be accompanied by good results.

Air-slacked lime is frequently purchasable direct from lime

kilns or from dealers in quick or burned lime, who have had it slack while in storage. When bought direct from lime kilns the purchaser may do well to stipulate that the lime shall be screened before delivery, in order that imperfectly burned pieces may be eliminated, since these would only increase the cost of handling and transportation, and would be objectionable in other ways.

Where the air-slacked lime is bought from dealers in burned lime as mentioned above, there may be imperfectly slacked pieces in the barrels, which can be screened out before the lime is applied. If the lime as purchased is applied to the soil and harrowed in at once, and no further treatment given, the lumps will slack later on, increasing considerably in size, and it will be liable to destroy seeds which come in direct contact with it, which may be decidedly objectionable, especially if the field is seeded directly to grass. To avoid such difficulty and also the disagreeable task of screening, it may be spread at once (provided of course that the lumps are reasonably few) and *immediately* harrowed in. It should then be left to itself for two or three days, when the lumps of lime will have absorbed sufficient moisture from the soil to fall to a fine powder, when it should again be harrowed and the operations of seeding can be proceeded with as usual. If a rain should fall during the period after the first harrowing a few hours will suffice to sufficiently slack the lime, though it could be more readily mixed with the soil after opportunity had been given for it to become somewhat dry upon the surface. Air-slacked lime is really a mixture of water-slacked and carbonate of lime, the amount of the latter depending upon the time of its exposure to the air. The water for making the water-slacked lime is absorbed from the moist air.

Quick, burned or caustic lime such as is used by masons can be bought of dealers everywhere, though in the purchase of such quantities as would be involved in extensive farming operations it can be bought direct from wholesalers and producers at lower rates.

Much of the lime enumerated above contains considerable amounts of magnesia, but this is sometimes beneficial and in experiments upon acid soils it has been found to be nearly if not quite as effective as air-slacked lime, even when the magnesia was applied alone. When associated with large quantities of lime, as it is in the case under consideration, there need be no fear of its doing injury, but on the contrary it may prove as valuable or

or almost as valuable as the lime itself. It is obvious that such lime requires some special attention so far as its application is concerned.

METHODS OF EMPLOYING QUICK LIME.

Owing to the size of the lumps great difficulty is met with in securing even distribution if quick lime is spread directly upon the soil; for this reason a plan frequently adopted is to distribute the lime in heaps of from forty to fifty pounds at intervals, depending upon the rate per acre at which the lime is to be used. Heaps of fifty pounds each twenty-one feet apart in each direction would give an application at the rate of about two and one-half tons per acre, and heaps of forty pounds each at the same distance one of two tons per acre. The heaps should be well covered with soil, which if it is fairly moist will supply water enough to the lime so that it will be well slacked in the course of a few days. It may then be spread from the heaps with a shovel, or as some seem to prefer, be loaded upon and then spread from a cart, stone "boat" or "drag." In case the soil is very dry from a fourth to half a pail of water, depending upon the apparent moisture of the soil, may be thrown over each heap before it is covered with earth.

One objection which some might raise to the above method of procedure is that the soil under the heaps is liable to get proportionately more lime than the rest of the field, and therefore to render the growth of the crops slightly uneven. This need not, however, constitute a serious objection to the method in actual farm practice, if reasonable care is exercised in spreading the heaps.

If the machinery of the farm includes a lime spreader, a course frequently adopted is to slack the lime on one side of the field, or in some other convenient location, and then load it into and distribute it by the spreader directly. In order to slack the lime in this way, two, to two and a half pails of water should be sprinkled over each cask of lime as it is emptied. The whole pile when complete should be covered thoroughly with soil. The following day the lime is usually fit for use, but if the spreader itself is not equipped with a screen the lime should be screened before an attempt is made to apply it. Any lumps remaining may then be further slacked. Care should be taken to separate the soil from the lime as far as possible to prevent clogging the spreader. The soil can be spread separately.

The most disagreeable feature connected with the use of lime is its action upon the throat, nostrils and eyes, but this may be largely overcome by resort to glasses adapted to the purpose, and to protection by a sponge or other artificial appliances such as are used for shielding the nostrils by those engaged in running threshing machines. Many people do not find any particular difficulty in applying lime without the use of such precautions, provided they exercise a little care in handling it. In the early morning, if the air is moist and still, little difficulty will be experienced. A sheet of burlap attached to the rear and sides of the lime spreader, and weighted with a piece of wood so that it will trail upon the ground, is found to be very effective in keeping the lime from flying about. This can be made out of old bags if other material is not more convenient.

When quick lime is used in small quantities it is sometimes placed in baskets and dipped in water for a moment and then dumped into a wagon body and allowed to slack for some hours, after which it is taken directly to the field and applied.

Under all circumstances lime should be harrowed in immediately or it is liable to cake with the soil and will not yield the best results.

Marl containing carbonate of lime such as is so extensively used for liming in many places, particularly in Europe, is not to be had in Rhode Island, and it is probable that the expense of shipment would practically preclude bringing it from elsewhere.

WHAT FORM OF LIME SHALL ONE BUY?

The form of lime to buy depends upon the market price, and since this is constantly changing it is impossible to give a definite answer to this question. It may, however, be stated that as a rule where the material must be carted long distances, or where the freight charges are considerable, quick lime is likely to be the cheapest form to use. The following figures will illustrate the advantage of employing quick lime in such cases.

If 178.6 pounds of carbonate of lime, the form of lime in which lime is chiefly present in wood ashes, were freed of its carbonic acid it would be found to weigh but 100 pounds, so that in every two loads of such lime there is really about seven-eights of a load of combined carbonic acid gas, which materially increases the expense of hauling it. When limestone is burned to make quick lime, carbonic acid gas is expelled so that where transportation is

expensive it is economy to burn the lime, in order to avoid handling the extra 78.6 pounds of material for every hundred pounds of actual lime transported.

When quick lime fully water-slacks, 100 pounds of it take up 32 pounds of water, thus increasing the weight nearly one-third. Ordinary air-slacked lime, owing to the fact that it has taken on some carbonic acid gas whereby a portion of it has become carbonate of lime, is even more expensive to handle than freshly prepared water-slacked lime. The longer it is exposed to the air the more it increases in weight in this way until eventually every 178.6 pounds of it really represents but 100 pounds of actual lime, or in other words it has all become carbonate of lime by continued exposure to the air..

IS IT BETTER ECONOMY TO BUY WOOD ASHES AT $11 PER TON OR TO USE QUICK LIME AND AGRICULTURAL CHEMICALS AT RULING PRICES?

Assuming that wood ashes contain 5 per cent. of potash, 1.5 per cent. of phosphoric acid and a total of 38 per cent. of lime and magnesia (calcium and magnesium oxids), and provided the magnesia were accorded the same value as the lime, their commercial value would be determined as follows: Five pounds of potash per hundred (five per cent.) equals 100 pounds per ton. Estimated at 5 cents per pound, the price at which potash can be bought in the form of high grade sulfate of potash (as muriate of potash it can be bought at 4½ cents), the value of this ingredient would be $5.00. Calculating the 1.5 per cent. of phosphoric acid or 30 pounds per ton at 5½ cents per pound, the price of soluble phosphoric acid (which is probably a too liberal allowance in favor of the wood ashes) in superphosphates, it would have a value of $1.65. Adding these sums we have as the value of the potash and phosphoric acids $6.65. Assuming now that lime in considerable quantity is obtainable at $1.00 per barrel of 250 pounds (it can frequently be bought from 75 cents to 80 cents per barrel delivered on board cars in Providence), and that it contains 95 pounds of lime (calcium oxid) in every hundred pounds, which it should, there would be in every ton 1900 pounds of lime, which at $8.00 per ton would cost (800÷1900) .421 cents per pound, or less than half a cent. Now calculating the 38 per cent. of lime and magnesia, or the 760 pounds in a ton of wood ashes, at the rate of .421

cents per pound, the value of the lime and magnesia (760 x .421) would be $3.20, which added to the value of the potash and phosphoric acid ($6.65 + 3.20) would make the total value of the wood ashes $9.85. Wood ashes at $11 per ton would therefore be somewhat dearer than the lime and chemicals. It is probable that upon a soil which was quite acid the carbonate of potash which is the form in the wood ashes, would have a slightly better effect than the sulfate, by virtue of its alkalinity, but the amounts involved are too small to have much practical significance; and on the other hand many plants contain considerable amounts of sulfur in certain combinations, and the sulfate of potash may on certain soils have an advantage on this account.

Another question which comes into consideration is that of handling the material. To obtain the same amount of phosphoric acid, potash and lime (or its equivalent) as is contained in one ton of wood ashes, there would be required about the following:

200	pounds	of dissolved boneblack,
250	"	of high grade sulfate of potash (48% potash),
800	"	of quick lime,
1250	"	total weight.

From this it will be seen that in a ton of wood ash 750 pounds more of material must be handled than when the other ingredients are used in their place, an important point to be considered where the cartage distances are great.

A point in favor of wood ashes is that they are pleasanter to handle than lime, but this would doubtless not militate seriously against the use of lime where the saving from its use is considerable.

It must be obvious from the foregoing that one would hesitate at the above prices for lime, potash and dissolved boneblack, to buy wood ashes *of the quality mentioned above*, at $11 per ton, particularly where the cost of hauling would be great. If the lime could be bought for 75 to 85 cents per barrel, and the other ingredients for the price given or for less, then the advantage would be still greater in favor of the lime and other substitutes.

From the figures and comparisons given above it is hoped that anyone can judge in particular instances what it is best to do. It may be possible that soluble phosphoric acid can at times be obtained at a relatively less price in the form of double superphos-

phate, dissolved phosphate rock or dissolved bone, in which case any one of these forms may be used instead of the dissolved boneblack.

On mowing fields, and for many crops, muriate of potash would produce as good results as the sulfate, and the 100 pounds of potash in that form would cost but $4.50, making thus $1.65 per each ton of wood ashes in favor of the substitute ingredients.

In regard to the probable economy of using leached ashes, or lime-kiln ashes, in any particular case, it is impossible to say what is most economical for the reason that these materials are often very wet when sold or offered for sale, and in this condition the amount of lime contained in a ton is always much less than where they are dry.

The same is true of air-slacked lime when it has been improperly protected. The value of such lime also depends upon its period of exposure to the air. Dry, fine, air-slacked lime, such as has been bought from time to time by this Station, has been found to contain from 68 to 75 per cent. of lime (calcium oxid). It is not enough to buy air-slacked lime at a given price per barrel, regardless of the weight of the package and of the percentage of lime present. It is sometimes sold in this manner, the buyer expecting to obtain 225 to 235 pounds of material per barrel, while owing to carelessness in filling the casks, or to their not having been shaken down, they are found to contain as little as 165 to 175 pounds per cask. Air-slacked lime has been offered for sale in this State at 65 cents per cask in carload lots, and for 75 cents in ton lots delivered on board cars. It can sometimes be had at seaport towns in Maine at 4 cents per bushel, delivered in bulk on cars or on board vessels.